RADIO *and* ELECTRICAL *Review*

TELEVISION - COMMUNICATIONS - SERVICE - SOUND

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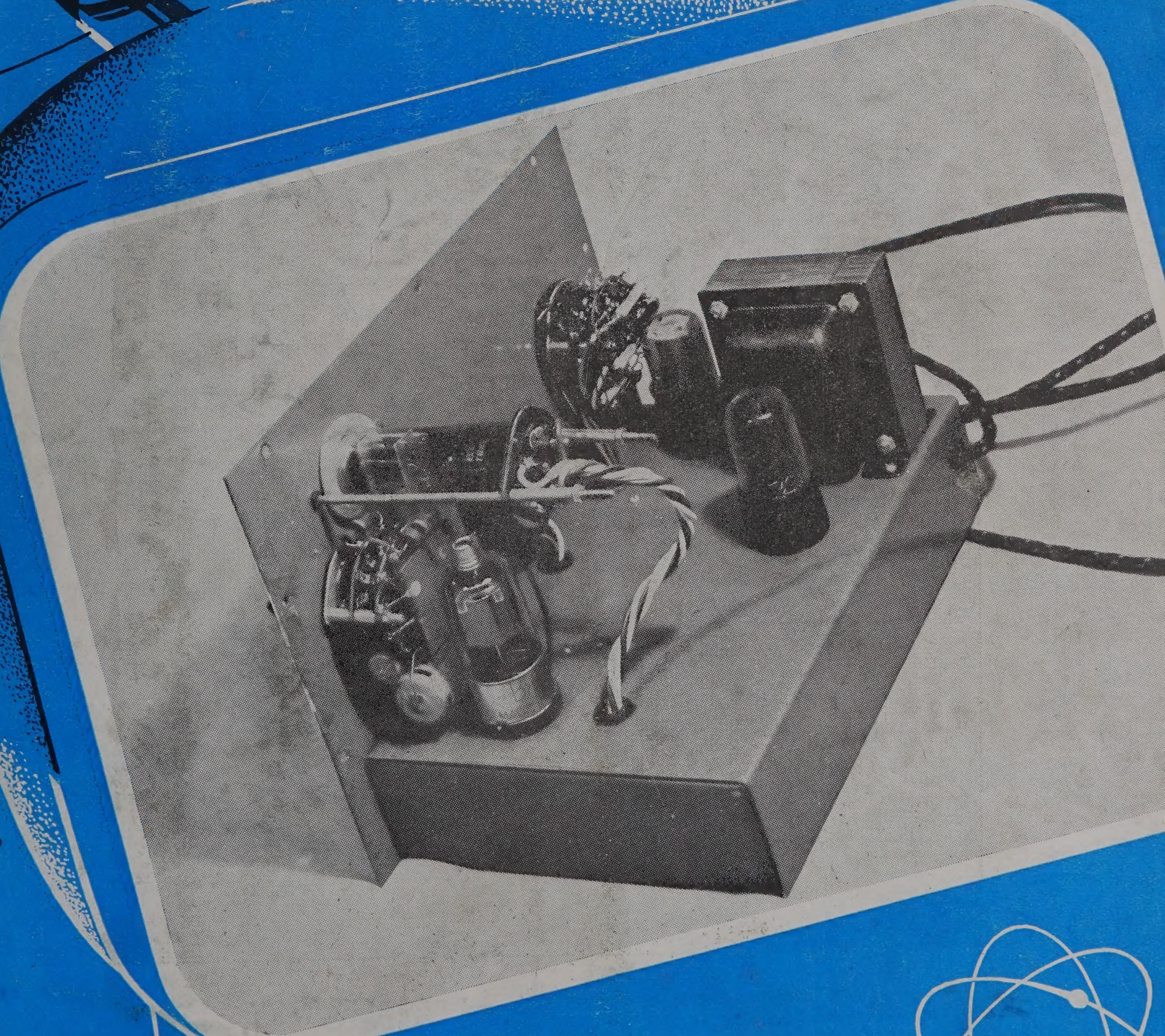

FEBRUARY, 1st 1956

VOL. 10, NO. 12

PRICE 1/10

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Radio and Electrical Review

Our Cover Picture this month shows the top chassis view of the R-C Bridge described on page 18.

Official Journal of
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The New Zealand Radio and Television Manufacturers' Federation.
The New Zealand Radio and Electrical Traders' Federation.
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VOL. 10, No. 12 FEBRUARY 1st, 1956

Contents

Sole New Zealand Distributors: Gordon & Gotch (N.Z.) Ltd., Wellington

PRINTED BY HARRY H. TOMBS, LTD., WINGFIELD STREET, WELLINGTON.

They've Stood the Test of Time!

ROLA

ISOCORE

Transformers

Ten years ago this month, Rola researchers were completing laboratory tests on a revolutionary new output transformer — the Isocore.

So advanced was its design that today, with production topping the 600,000 mark, Rola Isocore transformers are still leaders in their field.

Sealed against moisture, fully protected against the corrosive effects of electrolytic action and individually tailored to provide best power transfer and frequency response from the valve with which it is to be used, the Rola Isocore transformer is first choice with all who really know their radio.

New Report from KDKA's Log

OVER ~~56,050~~ 62,000 HOURS ON-AIR

RCA-5671 forced-air-cooled triode for 50-KW AM transmitters—the high-power tube with the thoriated-tungsten filament

. . . and still going strong*

Says T. C. Kenney, Chief Engineer of Station KDKA:

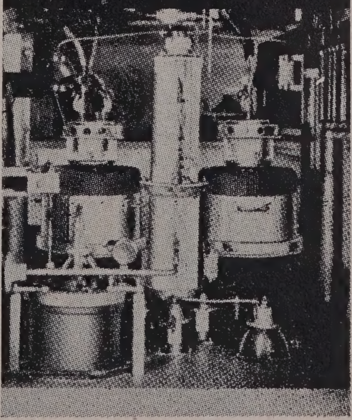
"Both RCA-5671 power triodes in our 50-kw. P.A. have now logged over 62,000 hours each since we first placed them in service more than seven years ago. And they are performing just as satisfactorily now as they did then."

The above is typical of reports received by RCA, proving the outstanding service obtained from all RCA tubes.

RCA-5671 is just one of many RCA types delivering "long-life" performance in broadcast transmitters throughout America. Broadcasters there appreciate the extra dividends that RCA power tubes can give them—in lower capital investment per hour of tube performance — minimum "down-time" — more stable operation.

Your local RCA Tube Distributor is always ready to fill your tube requirements promptly. Just pick up the phone and call him. You'll like his dependable service.

KDKA's 50-KW AM power amplifier, using two RCA-5671's



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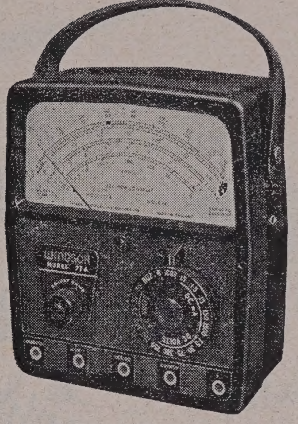

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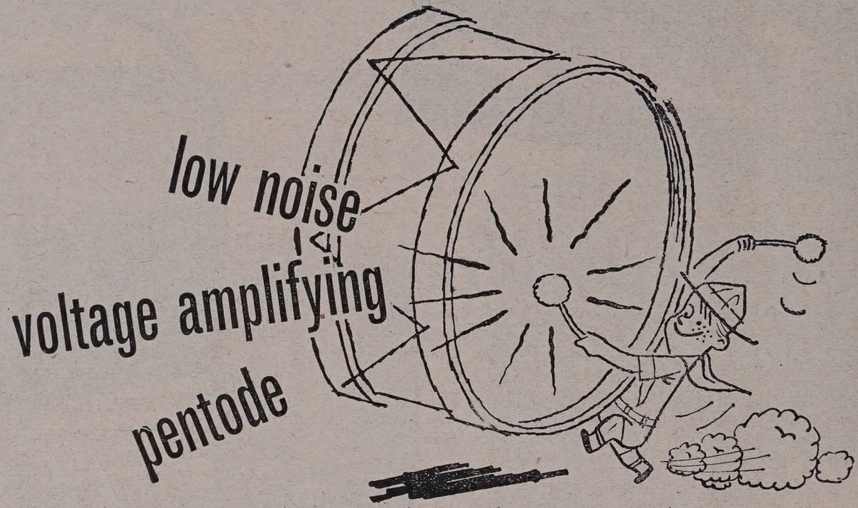

Z729

The home construction of high quality sound equipment is booming! Make sure of getting your share of this business by stocking a comprehensive range of Osram Audio Valves. The Z729 shown here is specially designed for use in the early stages of high gain amplifiers. It combines high gain, negligible microphony with the phenomenally low input hum voltage of 1.5μA.

Other valves in the Osram Audio Range include B309, N78, N727/6AQ5, KT61, and of course, the famous KT66 beam tetrode.

The Z729 data sheet appeared in the May, 1955, issue of "Radio and Electrical Review."

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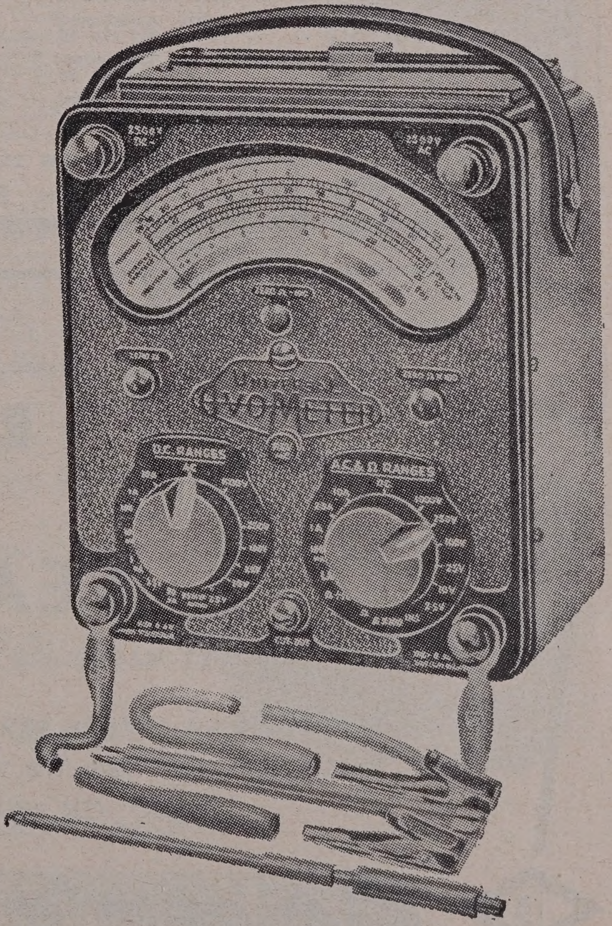

This is a high-sensitivity version of the world-famous Universal AvoMeter, having a sensitivity of 20,000 ohms per volt on all D.C. ranges and 1,000 ohms per volt on A.C. ranges from 100 volts upwards. A decibel scale is provided for audio-frequency tests, also a press button for reversing the movement to obviate the inconvenience of changing over the leads when encountering opposite potentials about a common reference point.

The instrument is compact and portable, and is protected by an automatic cut-out against damage through inadvertent overload.

D.C. VOLTAGE	D.C. CURRENT	A.C. VOLTAGE
2,500 V	10 A	2,500 V
1,000 V	1 A	1,000 V
250 V	100 mA	250 V
100 V	10 mA	100 V
25 V	1 mA	25 V
10 V	250 mA	10 V
2.5 V	50 mA	2.5 V

A.C. CURRENT	RESISTANCE
10 A	0—200 Megohms
2.5 A	0—20 Megohms
1 A	0—2000 Ohms
100 mA	

Size: 8½ x 7¼ x 4½ in. Weight: 6½lb. (approx.)

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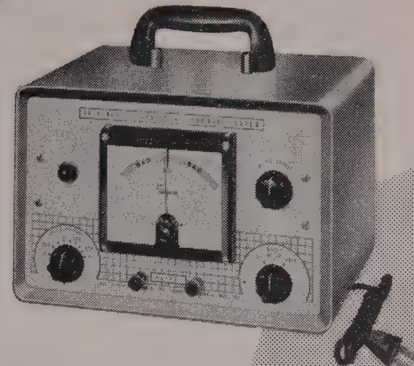

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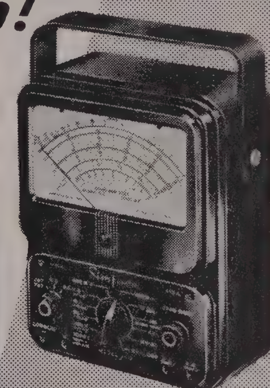

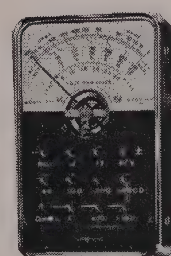

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Size: 7 15/16 in. x 6 in. x 2 15/16 in. Weight 4 lb.

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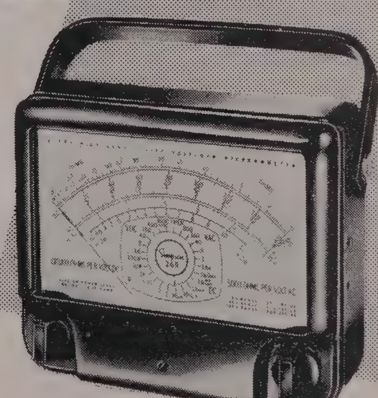
Decibels: —12 to +55 DB in 5 ranges.
Current, DC: 100 μa; 10, 100, 500 ma; 10a.
Ohms: 0–2K (12 ohms centre), 0–200K (1200 ohms centre), 0–20 meg. (120K centre).
Size: 5¼ in. x 7 in. x 3½ in. Weight: 3½ lb. shpg. wt. 6 lb.



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Size: 2¾ in. wide, 4½ in. high, and 1 in. thick.
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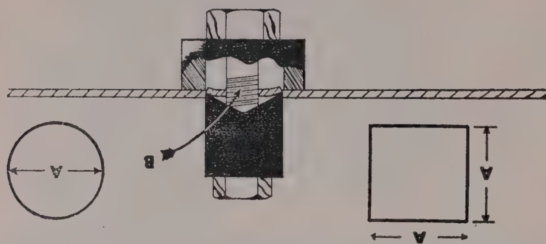

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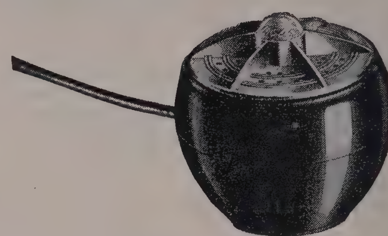

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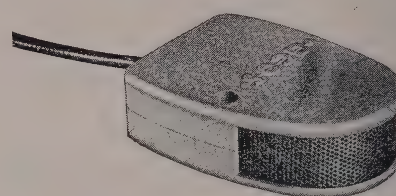

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Diameter	1 9/16 in.
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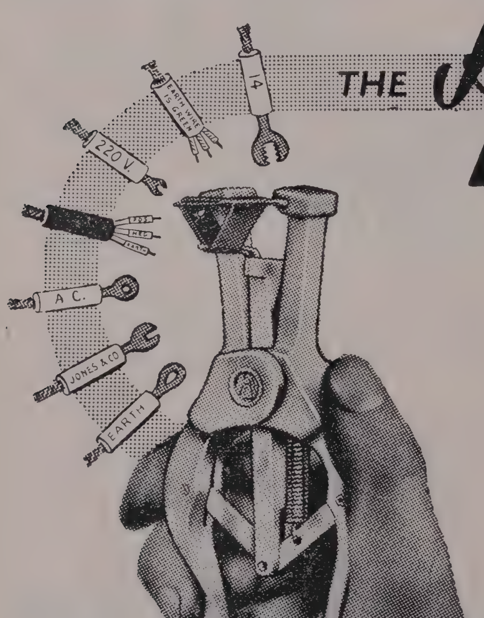

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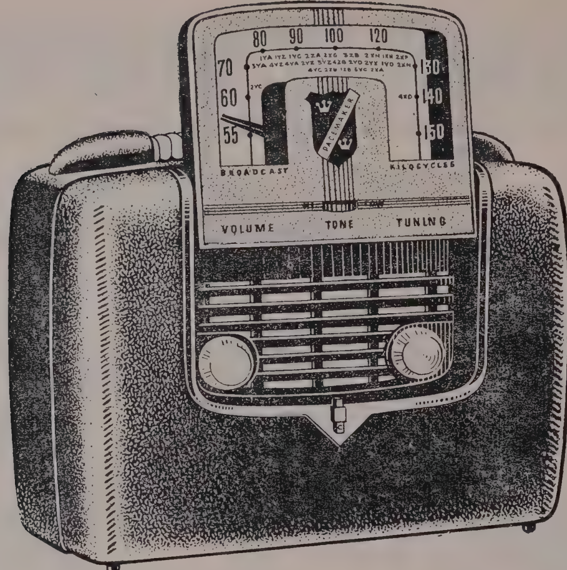

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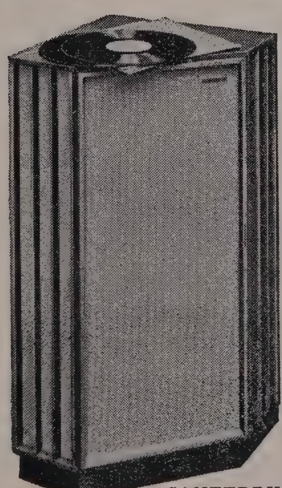

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Height 3ft. $9\frac{1}{2}$in., width 2ft. 8in., front to rear corner 1ft. $10\frac{1}{2}$in.

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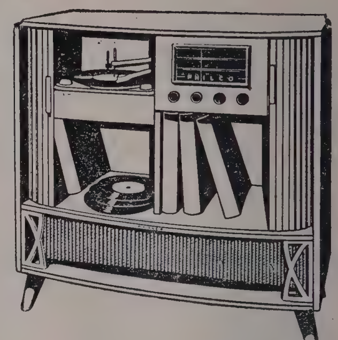

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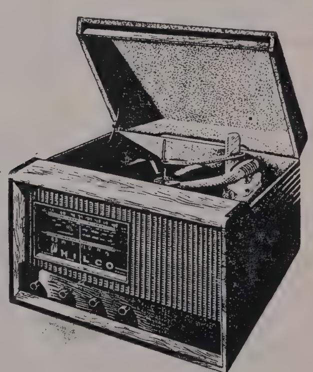

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A Remarkable Application Of Ultra-Sonics

The application of electronics to manufacture is by no means new, and is becoming more extensive in scope every day. Nevertheless, devices in which valve-operated equipment is used directly as a tool with which operations can be carried out on raw materials are quite rare. Perhaps the most important tool of this kind is the radio-frequency heater, which is used for a very wide range of jobs, many of which can be successfully done by no other means. It is thus a matter of some moment when a tool of fundamental newness comes to public notice, and we have no hesitation in devoting editorial space to what is perhaps the latest new machine tool to be developed by electronics engineers.

We refer to the ultrasonic drilling machine, which has only recently emerged from the development stage, and which can perform feats that are nothing short of amazing. For example, it can drill holes of any desired shape, and not just conventional round ones. Moreover, it can do so to an accuracy of 0.0005 of an inch. Its most unusual property is that these holes can be drilled in almost any material, however hard or however brittle. Unlike conventional drilling machines, it produces very little heat in the material being drilled, that it is able to handle materials which cannot be drilled by ordinary methods because of clogging and overheating. It can even bore curved holes!

The secret of the ultrasonic drill is to be found in the fact that the motion of the cutting tool is not rotary, but reciprocating. Indeed, it is not a drill at all, in the accepted sense of the term, but a hammer, delivering 20,000 blows a second. These blows do not erode the material to be drilled solely on their own account. An essential part of the machine is a suspension of silicon carbide in water, which is made to flow round the site of the proposed hole while drilling is in progress. Silicon carbide, next to the diamond, is the hardest substance known to man, and the action of the minute particles, under the high-frequency hammer blows, is to chip away very small pieces of the work, each particle being like a minute cold-chisel! By selecting the grade of silicon carbide particles to be used with the drill, the accuracy with which the final hole conforms to the shape of the drill can be varied at will. For instance, it is quite practical to make a rough cut to within about 0.003 of an inch, following this up with a finishing cut using very fine abrasive, giving an accuracy of 0.0005 of an inch.

How is all this done? By making use of the magnetostriction effect, whereby ferromagnetic materials suffer expansions and contractions in length when they are subjected to an intense magnetic field. The most suitable material for the purpose is nickel, which exhibits the effect more strongly than most magnetic materials. By taking a piece of this material and making it half a wavelength long (wavelength in this connection is that of sound in nickel) at the proposed operating frequency, it becomes resonant, and comparatively great elongations and contractions occur when a coil of wire is placed round it and excited with several watts at 20 kc/sec.; movements at the end of the rod of as much as 0.003 of an inch can be obtained with 50 watts of excitation, and this amount of ultrasonic power is enough to enable holes up to half an inch in diameter and half an inch deep to be drilled.

An unexpected, but valuable, feature of the ultrasonic drill is that the material which acts as the hammer, by being attached to the magnetostrictive rod, need not be hard. Indeed, brass is quite satisfactory. This means that for making odd-shaped holes, the "bit" can very easily be fabricated, even with such simple tools as hacksaws and files, if necessary.

There is a good deal that could be written about this most interesting new tool, but this should be enough to make us realize that there is still something new under the sun!

The "R. & E." DIGEST OF CIRCUITS No 3

For some weeks now the long-promised third *Digest of Circuits* has been in the hands of retailers throughout New Zealand, and those copies which had been ordered direct from our office have long since been delivered. Like the first two volumes of the same kind, this *Digest* has received a warm welcome from readers, and intending buyers are recommended to obtain their copies as soon as possible. It is impossible to reprint should it also be sold out, as have been the first two *Digests* for some time. The material in the latest issue is quite different from that in the other two, but everything has previously appeared in *Radio and Electronics* and *Radio and Electrical Review*, and references are given to the original full articles, most of which are available as back numbers.

Test Equipment

AN EASILY CONSTRUCTED R-C BRIDGE

Although commercial bridges of guaranteed accuracy are quite costly items, there is very little difficulty in building an extremely useful instrument in the home laboratory. The article below describes one such bridge which has a very wide range of measurement, both of C and R, and yet uses a minimum of specialized components. An advantage of the design is its very low building cost.

INTRODUCTION

We have never been able to understand just why so many of those who work with radio and electronic circuits seem to avoid building a few simple instruments whose usefulness is out of all proportion to their cost in both parts and time. How often does one find that the only measuring instrument available is a volt-ohm-milliameter? Useful as the latter is, its capabilities are severely limited when it comes to resistance measurements, and even more so as regards measuring capacities. Indeed, many instruments have only two resistance ranges, and no means of estimating capacity at all. They are very inaccurate, especially when battery voltages have fallen, and the range of values that they will measure is very limited. The bridge, on the other hand, can be made as accurate as we please, by dint of incorporating accurate standards, and in addition, can measure resistance over a range of a million to one, and capacity over a similar range, without difficulty. It cannot, of course, substitute for the voltage or current ranges of the V-O-M, but its usefulness is such that once one has possessed one, and become thoroughly used to making use of it for a wide variety of purposes, it becomes almost unthinkable to carry on without it.

The use of a bridge is not confined simply to making measurements of resistance or capacity. For much electronic work, accurate matching of pairs of components is more important than knowing their absolute values with extreme precision, and this is a job that is performed admirably by the bridge. It is not difficult to arrange a special scale for this work, which reads the percentage by which one of a pair of components differs from the other, with a reading range of, say, —20 to +25%. Other things, such as reading the power factor of leaky condensers, can also be done if slight additions are made to the basic circuit.

THE INSTRUMENT DESCRIBED

In order to make the instrument easy to build and calibrate for the novice as well as for the experienced worker, some of the facilities mentioned above have been left out, but even so, readers will find it quite comprehensive, and capable of doing almost anything a C.R. bridge is likely to be called upon to do. For a start, then, let us have a look at its specification.

(1) Measuring Ranges

Resistance: 1.5 ohms to 15 Megohms, in seven ranges.

Capacity: 15 $\mu\mu$fd. to 150 μfd., in seven ranges.

(2) Open Bridge

In this switch position, no standard is connected, so

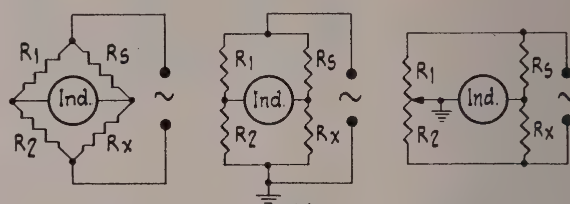


Fig. 1

that any external standard can be used. In this position, the bridge can be used to compare inductances as well as resistance and capacity.

(3) "Calibrate"

In this position the bridge has two equal resistors inserted to complete the circuit, and to enable the pointer to be set to the mid-scale mark, should it have come loose, or been otherwise disturbed.

(4) Percentage

In this position, which is equivalent to the "Open Bridge" position, but has a different range, any two similar resistors or condensers can be connected externally so as to complete the bridge circuit. Then when the bridge is balanced, the pointer reads on a special scale, the percentage difference between them, and indicates which is the greater or the smaller.

(5) Null Indicator

For cheapness and simplicity, a magic eye tube is used as the indicator for judging when the bridge is balanced. This works every bit as well as the much more expensive indicator that uses a meter movement, and has the advantage that no special precautions need be taken against overloading, when the bridge is out of balance.

(6) Oscillator

Most elementary bridges use the 50 cycle mains to energise the bridge. This has the advantage of cheapness, but causes a certain amount of difficulty when very small capacities or very large resistors are to be measured, because under these conditions, the signal fed to the indicator is in a very high-impedance circuit, and it is easy for the balance to be affected by stray capacities. These difficulties are alleviated by working the bridge at a higher frequency. Here we have chosen 1000c/sec., and an oscillator has been built into the bridge, giving some 20 volts at this

frequency. Another advantage of the oscillator is that when very low resistances, or high capacities are to be measured, the bridge voltage automatically drops owing to the inherently poor regulation of the oscillator. The current through the arms of the bridge never reaches a high value, and the measurements are made without heating the measured resistor of the standard appreciably.

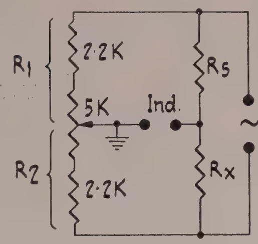


Fig. 2

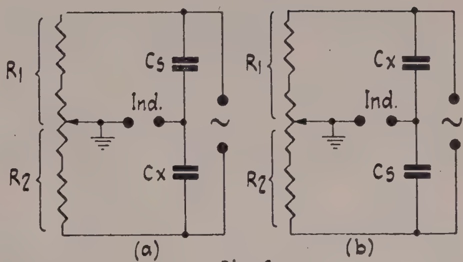


Fig. 3

PRINCIPLE OF THE BRIDGE, AND ITS FUNDAMENTAL CIRCUITS

The principle of the bridge is simply that of the Wheatstone Bridge, that can be regarded as the father of all bridge circuits. Strictly speaking the Wheatstone Bridge is operated with D.C., and is composed of only resistances. Its circuit is shown in Fig. 1 (a), in the form in which it is usually drawn. As far as the operating principle is concerned, it does not matter at all whether the bridge is fed with A.C. or D.C. All that must be done is to ensure that the indicator, or detector as it used to be called, can respond to the type of current that is used to feed it. The classical Wheatstone Bridge used D.C., and therefore had to have a sensitive galvanometer as the balance indicator. When A.C. is used, anything that will give an indication of the presence or absence of A.C. at the output terminals can be used as the indicator. Before the days of valves, a pair of sensitive headphones was always used, without any amplification. The bridge was then balanced by adjusting it until there was no sound in the 'phones. 'Phones can still be used, of course, and they can be made very sensitive indeed by employing a valve amplifier ahead of them. They are inconvenient to use, however, and other types of indicator are usually preferred. One good method is to retain the amplifier, rectify its output, and pass the rectified current through a sensitive meter movement. Balance is then indicated by minimum reading on the meter. The scheme used here is similar, but uses a magic eye tube instead of the meter. The rectified audio signal from the bridge is applied to the control grid of the magic eye tube. Thus when the bridge is out of balance the eye is closed but as the balance point is approached it opens and is completely open when no signal is coming from the bridge output, i.e., when it is balanced.

For our younger readers, it would be as well to enlarge somewhat on the bridge, and show how it works. To do this we have re-drawn the circuit in Fig. 1 (b). Here the method of drawing is such as to emphasize that the bridge is nothing more than a pair of parallel-connected voltage dividers. Across these voltage dividers is connected the oscillator, or the battery if the bridge is energized with D.C. The indicator, which could be shown as a pair of phones. is connected from one of the tapping points to the other. Now, if the ratio of R_1 to R_2 is equal to the ratio between R_s and R_x, there will be no voltage across the indicator terminals, and the bridge is said to be balanced. The reason for there being no voltage between the terminals of the indicator is simply that because each voltage divider divides the voltage of the battery or oscillator in the same ratio, the potential of each indicator terminal is the same. Thus, a meter, or the 'phones, will give no indication at all when the bridge is balanced, however great the voltage applied to the bridge may be. Suppose, for example, that R_2 is one ninth of R_1. Then, a tenth of the bridge voltage appears between the earth terminal and the left-hand indicator terminal. For the bridge to be balanced, R_x must have a value of one-ninth of R_s, for when this is so, the voltage between the earth terminal and the right-hand indicator terminal is also one-tenth of the bridge voltage, and there is no difference of potential between the two indicator terminals.

In Fig. 1 (c) we have re-drawn the bridge once more, this time with the earth point shifted to one of the indicator terminals. The circuit works in exactly the same way, whatever point is earthed, or even if there is no earth on the circuit at all. In addition, R_1 and R_2 have been shown as a single potentiometer, and we will see the reason for this in a moment. The Law of the bridge has been stated above, in words, but it is best written as a simple algebraic formula, thus:—

$$\frac{R_1}{R_2} = \frac{R_s}{R_x}$$

This can be re-arranged in this way:

$$R_x = \frac{R_s \,.\, R_2}{R_1} \qquad . \quad . \quad . \quad . \quad (1)$$

Now, if we know the values of R_s, R_1, and R_2 when the bridge is balanced, it is only a matter of arithmetic to work out what the value of R_x must be. This would be rather a slow and tedious way of measuring the resistance of anything, and an instrument would not be very useful if we had to stop and work out a sum every time we did a measurement, but this can be overcome by making R_1 and R_2 a potentiometer, as shown in Fig. 1 (c). Suppose we make R_s equal to 500 ohms, and that we have the potentiometer set exactly in the middle of its resistance. We then have $R_1 = R_2$, or $R_2/R_1 = 1$. If we now look at Equation (1) again, and put R_1 equal to R_2, we have the result that $R_x = R_s$. R_x in our example must therefore be equal to 500 ohms, if the bridge is to balance with the settings as shown.

By a similar process, we can calculate for any point in the potentiometer, what fraction (or multiple) of R_s, R_x must be in order to balance the bridge. We can then put a pointer and scale on the potentiometer, and inscribe the scale in fractions and multiples of R_s, which is the Standard resistor. If we now put an unknown resistor in the position of R_x, and adjust the

potentiometer until the indicator shows that the bridge is balanced, the value of the unknown can be read from the scale, simply by multiplying the reading by the value of the standard. This is how the direct-reading bridge, of which the present one is an example, functions. In order to make measurements over different ranges of resistance, different standards can be switched into circuit. When this is done, the same scale is used, only the multiplying factor changing.

The sharp-eyed reader may ask why different ranges are needed at all, because in theory, the bridge will measure any resistance from zero to infinity, whatever the value of the standard, R_s. This is quite true, but the difficulty is a practical one. If any attempt is made to calibrate the potentiometer from 0 to infinity, it will be found that at low and high readings, the divisions are very cramped, and it is impossible to set the bridge, let alone read it, with any accuracy. The usual way out of this is to calibrate the potentiometer from 0.1 or one-tenth, of the standard, to ten times the standard. This avoids the worst parts of the scale, and gives a measuring range of 100 to 1 for each standard. This wastes a small portion of the potentiometer, but the part wasted is of no practical value in any event. Even this arrangement results in a rather cramped scale at the upper end, and the best portion of the scale is the middle, over a range of some ten to one. However, if only this amount of the potentiometer is used, a considerable amount of it is wasted. To enable only the middle range to be used, and yet not waste any of the potentiometer, a simple dodge can be used. It is to put fixed resistors one on each side of the potentiometer. If these resistors are made large enough, the potentiometer can be made to cover only a very small range. All of it is used, and accurate readings are obtained over the whole scale. To pay for this advantage, we have had to sacrifice a certain amount of simplicity, and we have to put up with more ranges in order to cover the desired complete range. As an example of what can be done in this way, let us take the figures actually used in the complete bridge. The circuit is shown in Fig. 2. The potentiometer is 5000 ohms, and the fixed resistors are of 2.2k. each. This restricts the total measuring range to 10.7 to 1, so that we can now calibrate the potentiometer over a range of 10 to 1, and choose the standards for the various ranges as follows. The table gives the value of the standard for each range, and the values of resistance that can be measured on each.

TABLE 1

R_s	Range of R_x
5 ohms	1.5 to 15 ohms.
50 ohms	15 to 150 ohms.
500 ohms	150 to 1500 ohms.
5k.	1.5k. to 15k.
50k.	15k. to 150k.
500k.	150k. to 1.5 Meg.
5 Meg.	1.5 Meg. to 15 Meg.

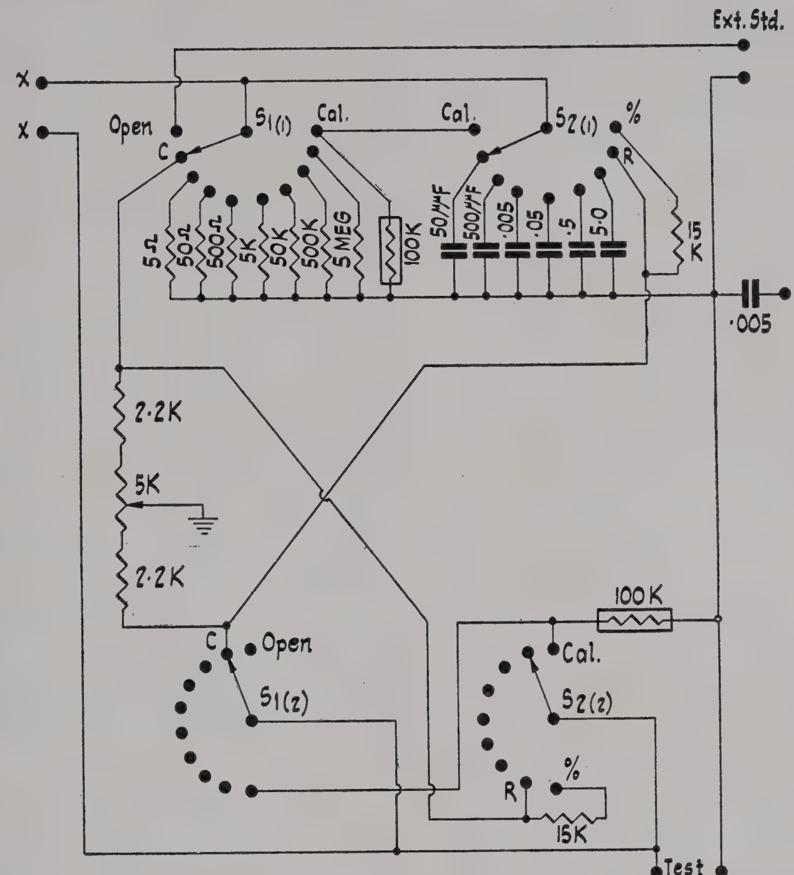
Of course, it is not essential to include all these ranges when the bridge is built. One can put in as few standards and switch positions as is desired, preferably leaving blank positions on the switches so that the missing ranges can be put in later, if desired, simply by adding the missing standards. For most purposes, the highest and lowest ranges could be omitted without diminishing the usefulness of the instrument very much.

CAPACITY RANGES

The principle of the bridge when it is used for measuring capacities is exactly similar to that for measuring resistances. The only difference is that one of the potential dividers which makes up the bridge circuit is composed of a pair of condensers, and the circuit becomes that of Fig. 3 (a); in this diagram C_x is the unknown condenser, whose value is to be found, and C_s is the standard, or known value, corresponding exactly to R_s in the resistance ranges of the bridge.

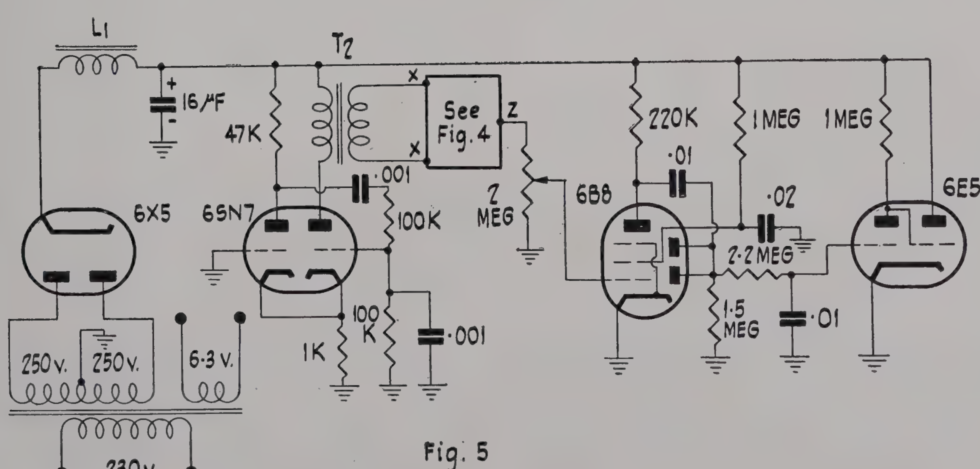
The practical circuit on the capacity ranges, however, is slightly different, and has the form shown in Fig. 3 (b). At first glance, the two might seem identical, but they are not. It will be noticed that the only difference between them is that in (b) the positions of C_s and C_x have been interchanged. If this is done, a good deal of labour is saved, and accuracy is gained, for had the positions of the standard and the unknown not been interchanged, the scale of readings would not correspond with the one used for resistance measurements. The reason for this is simply that the voltage division given by a pair of condensers takes place in the opposite way from one composed of resistors. That is to say, if we have two resistors, one nine times the other in value, and put them in series, one-tenth of the voltage across the combination will be found across the smaller resistor. If we do the same thing with condensers, we will find a tenth of the voltage not across the smaller one, but across the larger one. It is the **reactance** of the condenser that we are really measuring, not its capacity directly, and the reactance is inversely proportional to the capacity. Thus, a reactance scale would have its divisions running in the same direction as the resistance scale. This would not be very useful, however, because reactance also depends on frequency, so that in order to translate the reactance scale into capacity, the frequency would have to be accurately known. By making the scale read directly in capacity, we avoid all calculations, but must either use a separate scale, or else arrange things so that the resistance scale can be used for capacity too. The way to do this is simply to reverse the positions of the standard and the unknown, as we have illustrated. This means extra switching, but it is well worth while in terms of convenience in use. It is most awkward to have capacity increasing one way on the scale, and resistance increasing the other way.

For various reasons, the measurement of capcity is not quite as simple in all respects as is the measurement of resistance. For example, it is not possible to build the bridge so that there is no stray capacity between the terminals to which the unknown is connected. Thus, when we come to measure capacities of a few micro-microfarads, the results will surely be in error by the extent of this stray capacity. Fortunately, however, there is a way out of this, as we shall see. Then, at the other end of the scale, it is often desirable to measure capacities of several hundreds of microfarads. These are electrolytic condensers as a rule, and will obviously require a very large standard for any range that is to measure them. Unfortunately, electrolytic condensers are not suitable as standards, as their capacities change drastically with time, so



Ext. Std.
X
X
Open
C
S1(1)
Cal.
Cal.
S2(1)
%
R
5Ω
50Ω
500Ω
5K
50K
500K
5 MEG
100K
50μμF
500μμF
·005
·05
·5
5·0
15 K
·005
Z
2·2K
5K
2·2K
C
Open
S1(2)
100K
Cal.
S2(2)
R
%
15K
Test

Fig. 4



L1
T2
16μF
47K
X
X
See Fig. 4
Z
·001
100K
2 MEG
220K
1 MEG
1 MEG
·01
·02
2·2 MEG
6X5
6SN7
6B8
6E5
1·5 MEG
·01
100 K
·001
1K
250 V.
250 V.
6·3 V.
230 V.

Fig. 5

that some other solution must be found to this problem. However, the possible ranges that could be incorporated in this instrument are as follows, in Table 2:—

TABLE 2

C_s		Range of C_x			
50	$\mu\mu$fd.	15	to	150	$\mu\mu$fd.
500	$\mu\mu$fd.	150 $\mu\mu$fd.	to	0.0015	μfd.
0.005	μfd.	0.0015	to	0.015	μfd.
0.05	μfd.	0.015	to	0.15	μfd.
0.5	μfd.	0.15	to	1.5	μfd.
5.0	μfd.	1.5	to	15	μfd.

THE COMPLETE INSTRUMENT

The bridge circuit itself is at no stage more complicated than the small circuits that we have already been considering. However, the complete instrument looks a little more fearsome, but this is only because of the necessity for making all the ranges available at the turn of a switch, and because of the necessity for reversing the positions of the unknown and the standard when on the capacity ranges. Altogether, there are thirteen ranges, not counting extra switch positions for "Calibrate" and "Open Bridge". Unfortunately, ordinary wafer switches have a maximum of twelve positions, and a minimum of fifteen are needed. At first there might seem to be no way out of this impasse other than to reduce the number of ranges, or to find some special switch. Such switches exist, but they are much too expensive for the ordinary run of purposes. However, there is a solution to every problem, and the way out of this is to use two switches instead of one. Two twelve-position switches give a total of 24 possible positions, which leaves some to spare, even after allowing for the fact that the actual arrangement used reduces slightly the number of positions available. The scheme is to have one switch for bringing in the resistance standards, and another entirely separate for inserting the condenser standards into the circuit. Then, the switch labelled with R ranges has a position labelled "C", while the one which selects the C ranges, has a position called "R". To use this system, the R switch is set to the position "C", after which the appropriate range can be selected by means of the C switch. In the same way, to measure resistance, the C switch is set to the "R" position, and the appropriate range is selected on the R switch.

THE FULL BRIDGE CIRCUIT

The full bridge circuit is shown in Fig. 4, without the oscillator and indicator circuits, which are really quite separate things. The circuit is that of Fig. 2 on the resistance ranges, and of Fig. 3 (b) on the capacity ranges. S_1 is the switch for selecting the appropriate resistance standards, and comprises two banks or wafers, one for switching the standards arm, and the other for the unknown arm. The wipers have all been drawn in the correct position for the first capacity range. Similarly, there are two wafers on the capacity switch. The upper wafer of the R switch and the lower one of the C switch are so interconnected that when the former is in the C position, as drawn, the condenser standard forms the upper right-hand arm of the bridge, and the unknown the lower right-hand arm. When the C switch is set to the R position, the resistance standard becomes the lower right-hand arm of the bridge, and the unknown, the upper right-hand arm. With the R switch in the "Cal." position, the two equal resistors labelled "Cal." on the diagram complete the bridge circuit. The bridge is then balanced when the measuring potentiometer is in the exact centre of the total 9.4k. that makes up the ratio arms. However, for this connection to be effective, the C switch must also be in the "Cal." position, or in the "Open" position, because if it is on one of the capacity range positions, it places one of the capacity standards in shunt with the upper "Cal." resistor, and the bridge will not balance.

It will be seen also that the two "Cal." positions can be used. In one, the C switch is set to "Open", and the R switch to "Cal."; in the other the situation is reversed, with the C switch set to "Cal." and the R switch set to "Open". These two positions differ only in that the positions of the "Cal." resistors are reversed. Ideally, these resistors should be absolutely identical, but it is rather too much to expect them to be so. However, resistors accurate to 1% are neither expensive nor difficult to get these days, and with the aid of these two "Cal." positions, their slight inequality can be taken care of. Let us see what happens if they do differ slightly, which in practice they always will. In one "Cal." position, the setting of the potentiometer for balance will then be slightly displaced from the exact centre of the ratio arms. If now the bridge is set to the second "Cal." position, the balance point will still be displaced, but on the other side of the exact resistance centre. If the two balance points are marked, the correct place for the pointer is the one which puts the two callibration marks at equal distances on either side of the scale mark labelled "1.0". If the calibrating resistors were exactly equal, the two balance points would coincide.

SELECTING "CAL." RESISTORS

The above principle enables us to select pairs of resistors that are as nearly equal as possible. In this way, a pair of "Cal." resistors can be chosen from a number of ordinary 20% tolerance ones—provided a close enough pair can be found. The method is to wire one of them temporarily in one of the "Cal." resistor positions, and to connect another to the remaining "Cal." position. The balance points are then found with the two "Cal." positions of the switches, until the pair is found which makes the two balance points as nearly coincident as possible. The same thing can be done by setting the bridge to the "Open" position. This means setting BOTH the C and R switches to the positions marked thus. Then, no standard is connected to the bridge, and the circuit is as shown in Fig. 5. The two resistors to be compared can then be attached to the two pairs of terminals, one of which is the normal test pair, and the two balance points found by reversing the positions of the pair manually. The second pair of terminals on the panel should be labelled "External Standard", for the main purpose of the open bridge position is to enable new ranges to be temporarily set up by connecting a new standard to these terminals.

CIRCUIT OF THE POWER SUPPLY, OSCILLATOR, AND INDICATOR

These have been kept separate from the bridge circuit in order to emphasize the essential simplicity of the latter. Any attempt to draw the whole instrument in a single circuit tends to make it look more

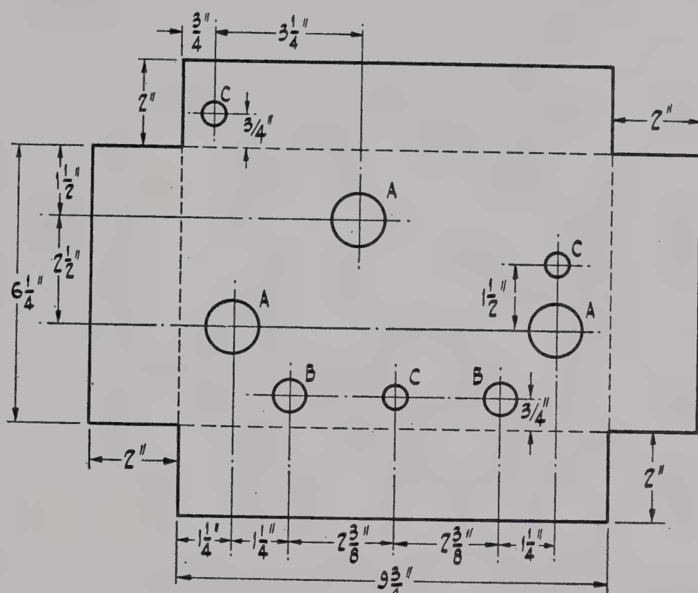
complex than it really is, whereas when it is broken down into its component parts, the arrangement is neither difficult to follow nor difficult to read. In Fig. 5 we have drawn the power supply, oscillator, and indicator circuits.

The power supply is conventional in every respect, and requires no special comment. The oscillator is a conventional cathode-coupled one in which the output is obtained via a step-down transformer in the plate circuit of one of the triodes. On the ranges in which the bridge impedance is medium or high, the oscillator delivers approximately 20 volts peak to the bridge. On the low resistance and high capacity ranges, this voltage automatically drops, and is only about 5 volts peak on the lowest range. This feature is desirable, because, as mentioned earlier, it prevents large currents from being passed through any of the bridge arms. This is really quite important, because carbon resistors, which will frequently be measured, change their values quite materially when they get hot. Also, such resistance changes are not always reversible, which means that the original resistance is not recovered after the resistor has cooled down. In the case of electrolytic condensers, a low test voltage is necessary if they are to be measured without polarizing them with D.C., while the measurement is in progress. Apart from this, it is quite permissable to test them without D.C. polarization, as long as the A.C. voltage is kept low.

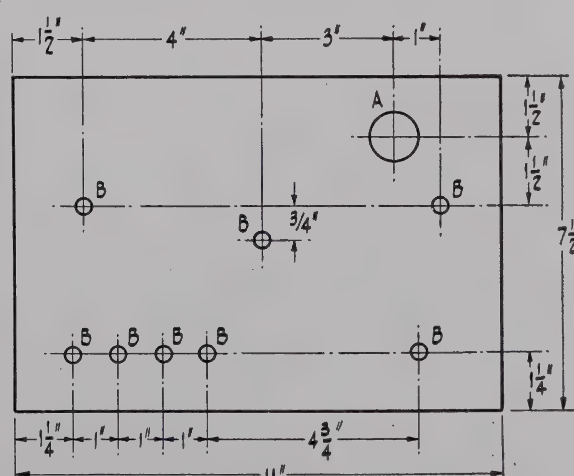
Some readers might wonder why the oscillator has been provided with an output transformer. It is simply that the bridge circuit can be earthed only at one point at a time. In this case, we have chosen to earth the junction of the ratio arms (i.e., the moving arm of the potentiometer). The reason for this choice is that it effectively prevents hand-capacity effects from becoming noticeable, especially when the other arms of the bridge are high in impedance. This being the case, both terminals of the signal source must be insulated from ground, and the only satisfactory way of doing this is to use the secondary winding of a transformer. It is much more convenient in a bridge of this sort to have one side of the detector earthed, and this is what we have done by earthing the junction of the ratio arms.

The indicator circuit is very simple. It comprises a pentode audio amplifier, a diode rectifier in the same envelope, and a magic eye tube. The latter, it will be noted, is a 6E5, which has been chosen because of its special characteristics. It is the most sensitive type available, and does not have a remote-cut-off characteristic like the 6U5. Alternatively, an EM34 could be used, provided the sensitive shadow is the one that is observed in finding the balance point. In use, the bridge output keeps the eye closed, except when the bridge is balanced. At this point, the bridge output is zero, or very close to it, so that as balance is approached, the eye opens, and the balance point is indicated by the setting of the bridge potentiometer that gives the widest opening of the eye. At the input to the amplifier is a 2 Meg. potentiometer which acts as a sensitivity control. For the middle and high-impedance ranges, the indicator is much more sensitive than is strictly necessary, but the excess gain is useful because on the low-impedance ranges, for example, the bridge voltage is reduced. On the two lowest resistance ranges, for example, it is advisable to wind the sensitivity control to maximum when the most sensitive indication is required.

(To be continued)



Drillings: A = $1\frac{5}{32}$" Dia. B = $\frac{3}{4}$" Dia. C = $\frac{1}{2}$" Dia.



Drillings : A = $1\frac{1}{8}$" Dia. B = $\frac{3}{8}$" Dia.

Audio

SOME POINTS ABOUT SQUARE-WAVE TESTING

INTRODUCTION

Since the published photographs of square-wave tests that have been carried out in our laboratory appeared, we have been promising ourselves to write a short explanatory article, clearing up some of the points about which we have purposely said nothing up till now, so as not to confuse the issue. One correspondent has written to us and has raised at least one of the points mentioned, so the time is perhaps opportune for the proposed article. The first and most important thing that should be cleared up is the question of the power rating of an amplifier.

POWER RATINGS OF AMPLIFIERS

Everyone is aware that the existing method of rating the power output of amplifiers is to state the maximum power output at a frequency of 1,000 c/sec. What is often not realized is that implicit in this statement is the fact that the power is measured by exciting the amplifier with a sine-wave at the stated frequency. So far, so good. This system appears quite satisfactory until it is realized that many amplifiers will not deliver this rated power over a very wide frequency range. Many specifications of amplifiers are positively misleading, because they quote the maximum power output at 400 or 1,000 c/sec. ONLY, and then go on to show a frequency response curve WITHOUT STATING AT WHAT LEVEL THE CURVE WAS TAKEN. When this is done, the assumption the manufacturer hopes the reader will make is that the frequency response curve will be an indication of the maximum power available over the frequency range. Now, unless the response curve is a curve relating maximum undistorted power output to frequency, and is specifically stated as such, the reader is very much misled if he falls into the trap of assuming that it is so. The shape of the response curve, and therefore its meaning, depends on the conditions under which it is made. For example, what engineers know as a frequency response curve is always taken at such a low level that the output power is within the capability of the amplifier at all frequencies. A power output curve, on the other hand, is one which relates the maximum undistorted power output to frequency. It looks just the same as a response curve, because it is almost always indicated in decibels below the mid-frequency power output, and because the frequency scale is identical to that of a frequency response curve.

Now it is characteristic of almost all amplifiers that a response curve taken at a low output level, such as 50 milliwatts, is flatter at both low and high frequencies than is the power output curve. This is why most manufacturers give a response curve and hardly ever a power output curve. Unfortunately, however, an amplifier can be regarded as overloaded and producing distortion if the signal **at any one frequency** drives it past the point at which the output is undistorted. Thus, the maximum **useful** power output should be quoted as **the maximum power the amplifier will deliver at all frequencies within the audio range.** This power rating will obviously depend on the shape of the power output curve, and on the upper and lower limits that are said to define the audio range. Unfortunately, no one seems to have adopted such a method of rating amplifiers, most probably because it would lead to a rather remarkable down-rating of most existing ones. Surely, if one buys a 10-watt amplifier, one should be entitled to expect it to deliver 10 watts at any frequency within the frequency range that is of interest. The response curve purports to show that the amplifier functions over a wide range of frequencies—say, from 30 c/sec. to 20,000 c/sec., but how many amplifiers will do so at their rated power output? Precious few, we would venture to predict.

Now the ability to deliver power from a sinusoidal signal generator is not necessarily a measure of the useful power output of an amplifier when it is used to reproduce music, because the waveforms contained therein are frequently anything but sinusoidal. Many of them are what is known as transient. That is to say, they are of a short-lived, fleeting nature, and as such bear little or no relation to a sine-wave. Theoretically, in order to reproduce perfectly a transient phenomenon such as a single loud bang on a bass drum, or clash of a cymbal, an electrical system should have a frequency response extending from zero to infinity. Now, we are not able to build audio amplifiers like this, and thus must put up with imperfect reproduction of transients. Even so, we do want them reproduced as accurately as possible, and so we use amplifiers whose response extends to both lower and higher frequencies than the limits of audibility. Or, rather, we should do so, if we want the utmost realism from our amplifiers. This is the reason why the testing of amplifiers with square-wave signals is considered by many knowledgeable people to bear a much closer relationship to the actual conditions under which an amplifier is used than is the time-honoured method of using single frequencies, or sine-waves (which is the same thing). A square-wave is made up of a repetitive series of transients, and therefore also requires a very wide pass-band for its proper reproduction. Because of this, the testing of an amplifier with square-waves at two or at most three frequencies, is equivalent to testing it with a large number of frequencies simultaneously.

Because of this, the use of square-waves will give in a very short time the same information as can be had from a comprehensive series of measurements with sine-waves. Indeed, it has been proved mathematically that if the form of the transient response of a system is known, it is possible to predict the frequency and phase response characteristics. Similarly, if one measures the frequency and phase responses of a system, it is equally possible to predict the transient response. It is unfortunate, however, that both methods are extremely time-consuming, so that the best solution to the amplifier question is a combination of sine-wave and square-wave tests.

As a result of our own experiments, we have suggested that one thing that should be revised is the method of rating the power of amplifiers, and that this should be done in the following manner.

SUGGESTED NEW METHOD OF RATING POWER OUTPUT

The amplifier is excited with a square-wave of 1 : 1 mark-space ratio, and the input amplitude is gradually increased from zero until it is observed that the general shape of the output waveform commences to change. When this happens, it is an indication that at some frequency within the range required to reproduce the square-wave concerned, the amplifier is reaching the overload point. By this means, the maximum peak-to-peak output voltage that the amplifier will provide with the particular square-wave input frequency used is found and noted. The same test is caried out at three frequencies—30 c/sec., 400 c/sec., and 10,000 c/sec. At one of these, the maximum peak-to-peak output voltage will be found smaller than at the other two. The suggested method of power rating is to calculate the power contained in a sine-wave of peak-to-peak voltage equal to that of the square-wave which gives the smallest maximum output of the three test square-waves.

WHY THIS PROCEDURE?

This is the point at which some readers have been a little confused. The obvious question is, "Why go back to sine-waves to take the final power measurement?" And the answer is by no means obvious until it is pointed out. The reason for this procedure is that in the practical, as opposed to the theoretical, case, it is almost impossible to find the power in the load when the waveform is "square." In the theoretical case of a square-wave of 1:1 mark/space ratio, it is quite easy, because the R.M.S. value of such a wave is equal to the peak value, and the power is equal to E_{pk}^2/R, where R is the load resistance and E_{pk} is the peak voltage. With a sine-wave, the R.M.S. voltage is 0.707, or $1/\sqrt{2}$ times the peak voltage, so that the power is $(0.707\,E_{pk})^2/R$, or $0.5\,E_{pk}^2/R$. In other words, the power in a square-wave is **twice** that in a sine-wave of equal peak voltage, provided that the mark/space ratio of the square-wave is unity.

Unfortunately, this simple relationship holds only when the square-wave is a theoretically perfect one, so that, in any practical case, it cannot be used. Such matters as the finite slope of the rapid transitions in the square-wave, the droop of the flat-top portions, and the quite unpredictable amounts of ringing that occur, make the actual power in a practical case quite different from the theoretical. With a sine-wave, on the other hand, such small distortion as occurs in a good amplifier has a negligible effect on the actual power delivered to the load, which makes it an easy matter to calculate the power.

Now, for practical purposes, the important thing about an amplifier is rather the peak-to-peak output voltage it will develop across the load, since this can be taken as a measure of its ability to handle transient phenomena. Thus, the method we have outlined above takes this fact into account, and then obtains a figure for power output by relating to it the power contained in a sine-wave of equal peak-to-peak voltage in the same load. It has been suggested that the figure thus obtained should be termed the "Equivalent Sine-wave Power for Square-wave Inputs," or, as a short title, the "Equivalent Sine-wave Power of the Amplifier."

RELATIONSHIP BETWEEN SINE-WAVE AND SQUARE-WAVE TESTS

Earlier in this article, we mentioned that, provided enough data are taken, sine-wave tests can give identical information to that obtained by means of transient or square-wave tests. A little thought will show that, since square-waves contain a multiplicity of frequencies, using a square-wave is equivalent to testing the amplifier simultaneously over a wide bandwidth. There is thus some reason for believing that the method we have just outlined for making square-wave tests the basis for the measurement of power output is similar in effect to taking a curve of power output versus frequency. For example, consider the situation when a 10 kc/sec. square-wave is used. If the frequency components at, say, 50 kc/sec. and 70 kc/sec., which are the fifth and seventh harmonics respectively of the fundamental, are of such an amplitude that the amplifier can no longer handle them without distortion, it is reasonable to assume that the square-wave will be distorted in some way. This distortion is distinct and separate from the overshoot and ringing that always occur in some degree, and can be quite readily observed, long before the input to the amplifier has been raised to the point where limiting of the lower frequency components takes place. Thus, the criterion that the general shape of the square-wave must not change if the square-wave output voltage is still to be considered "undistorted," is a valid one, and has very much the same practical effect as would drawing a curve of the undistorted power output versus frequency, with a sinusoidal signal.

We make no claim that in this work we have discovered any new principle. What we do believe, though, is that there is a great need for a new method of rating power output of amplifiers, and the practical work that has been done confirms this view. It has been found, for instance, that the closer the correspondence between a low-level frequency response curve and a power output curve, the more closely does the figure for the proposed Equivalent Sine-wave Power agree with the conventionally measured maximum power output with a sinusoidal signal at 1,000 c/sec. This means that the Equivalent Sine-wave Power is a figure which can be used to give a real comparison between the power-handling ability of amplifiers **when they are used to reproduce music and speech.** The use of this test method has also shown that the ultra-linear amplifier, as interpreted by some designers at least, gives no greater transient output than do the same valves when triode-connected. We now come to some points about the ultra-linear connection that have been raised by a correspondent.

ULTRA-LINEAR AMPLIFIERS

Our correspondent makes the point that the circuit of the Osram 912 main amplifier which we tested did not include the 0.001 μfd. condensers that the original has, connected directly between screen and plate of each output valve. He is quite correct. The oscilloscope patterns published were for the circuit omitting these condensers. This was done for one reason only—namely, in deference to the "theory" of the ultra-linear amplifier, which holds that the screen-grids of the output tubes should be tapped down the transformer primary **at all frequencies.** Inserting these condensers must have the effect of turning the amplifier into a conventional triode-connected circuit at the highest frequencies, and so, if the system works at all, the condensers should be omitted so that it will function in the same way over the widest possible frequency range. In practice, it was found that inserting these condensers had no effect other than to lower the frequency of the peculiar waveform that appears to be characteristic of the screens when excited with square-wave signals. The behaviour was

still the same in kind, and this leads to the conclusion that the odd behaviour of the screens is due to incomplete coupling between the screen sections of the transformer primary and the remainder of the winding. That is to say, the very lightly damped and quite low-frequency oscillation in the screen circuit is due to resonance between the leakage inductance and the screen-plate capacity of the valve. Adding capacity between screen and plate merely increases this capacity artificially, thus lowering the oscillation frequency.

The behaviour just outlined would seem to indicate that if an ultra-linear amplifier is to work with transient signals even as well as the corresponding triode circuit, special effort must be put into the design of the output transformer in order to reduce the leakage inductance between the four sections of the primary winding. It is quite possible that, if this is done, the advantages of the ultra-linear circuit when handling sine-waves can be extended to include improved performance on transient signals. It does appear, however, that, even if this turns out to be the case, the additional expense involved in properly applying the ultra-linear technique may easily offset the advantages obtained, except in applications such as public address, where it is conventional to regard as acceptable performance that falls far short of high-quality reproduction.

It is hoped before long to carry out tests on ultra-linear amplifiers using specially wound output transformers, with very low leakage inductance in the primary windings, in order to see whether these predictions are borne out in practice.

Another thing that has so far received no mention is that the work carried out by Langford-Smith on ultra-linear amplifiers has shown that the optimum screen tapping point on the winding is widely different from that used, for example, in the Osram 912 and other circuits. He has also shown that the optimum load impedance for an ultra-linear amplifier using the best screen tapping points differs appreciably from that for triode operation of the same valves. This being so, it is not possible to compare the best performance obtained with the ultra-linear connection with the best performance in triode connection, without using different output transformers. It appears, therefore, that there is considerable work to be done before the question of which is the better arrangement for high-quality reproduction of music can be settled.

N.Z.A.R.T. NOTES

Amongst recent ham visitors to the Dominion we were privileged to meet Evelyn Scott, W6NZP, of Long Beach, California, and Howard Wills, G3EBE, from Purley, Surrey, England. After travelling through many parts of New Zealand, Evelyn has become another ambassadress for the scenic wonders of our country. She and her husband, Harold, literally passed from amateur to amateur throughout the length of the Dominion, thus having virtually a conducted tour of the country—another aspect of the goodwill linking amateurs in all parts of the world. The Scotts left New Zealand to continue their Pacific tour in Australia, where, we are sure, they also lacked for nothing on their arrival.

Howard Wills came on a business visit, and consequently his scope was somewhat limited. His glimpse of New Zealand covered only a small portion of the South Island as he came to install some radar equipment at the International Airport at Harewood. He was introduced to the familiar "Ole Man Nor'-wester" with a vengeance, when a parabola antenna was picked from its moorings, tent-pegs and all, and bowled across the field, much to his disgust and fear for the safety of the equipment. However, all was well.

With the advent of "Operation Deep-freeze," Christchurch will see more than its share of American amateurs. This expedition will also provide many newer ZL amateurs with a chance of working the Antarctic Continent, which has been in the "very difficult" category for some time. Furthermore, the news that a ZL amateur, ZL2SP, P. D. Mulgrew, has been selected to join the New Zealand party, livens the hope that we may be represented on the amateur bands from the Southern Continent.

Amateurs who collect "wallpaper" in the shape of certificates will be interested in the news that R.C.A. have instituted an award entitled the "Antarctic Argentine Certificate." This certificate (Certificado Antarctico Argentino) is granted to every radio amateur holding a licence for a station officially recognized, proving QSO with a LU station located in the Argentine Antarctic. Special stamps will be provided for affixing to the CAA for every different Argentine Antarctic detachment, base, village, etc., communicated. Every authorized band, CW or phone, may be used. In order to obtain the award, the QSL must be sent to the R.C.A. at Avenida Libertador General San Martin 1850, Buenos Aires, Argentina. QSOs must be dated after November 20th, 1945, when QRT finished in Argentina.

Although only one card is required to commence working for this award, we think that it will be one of the hardest to obtain, as the activity in this area is limited. Some may try for months, and yet there must be the lucky ones. Have a look amongst those cards. You may qualify even now. Don't forget to enclose that reply coupon.

In further monthly notes in "Radio and Electrical Review," we shall give summaries of some of the lesser known awards available to amateurs. Many of these are rarely published, and this feature of our notes might help fill the gap and perhaps be the means of assisting some certificate hunters to add to their collection!

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No. 100: Transistor Power Converters—Part 3

Having outlined the principles upon which transistor D.C. converters are designed, we propose now to give details of some representative completed designs, which will illustrate the inherent possibilities of this class of power converter. In addition, some variations on the basic converter circuit will be indicated, showing how for some purposes the use of voltage-multiplying rectifier systems can improve on the original.

SUPPLY FOR A PORTABLE RADIO SET

An interesting and intensely practical converter is one designed to replace the B battery in a battery-operated portable receiver. The unit to be described has been designed for a set which uses the modern D96 series of battery valves, and has the following line-up: DF96, R.F. amplifier; DK96, frequency changer; DF96, I.F. amplifier; DAF96, detector, A.V.C., and A.F. amplifier; and DL96, A.F. power amplifier. The HT requirement is for 90 volts at 10 ma

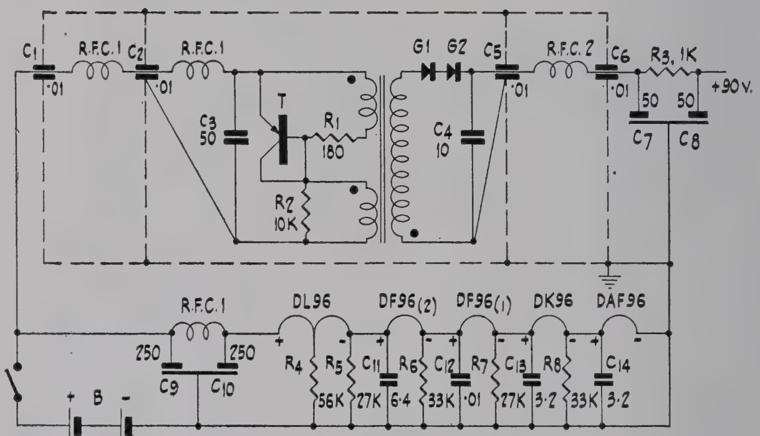

Fig. 1

Although it would be possible to design the converter to operate from a 3-volt battery, with the valve filaments run in series-parallel off the same battery, it is preferable to use a higher L.T. voltage if possible, because, by so doing, the peak collector current in the transistor is considerably reduced and the efficiency is increased. It has been decided, therefore, to operate from a 9-volt battery, with the valve filaments in series, as shown on the circuit diagram. The filament current is 25 ma., and the drain due to the converter is 157 ma. Thus the total current drain of the receiver is 182 ma. from the 9-volt battery.

The pot core is a type D36/22, with an air-gap of 0.1 mm. between both the central core and the external shell and one of the end plates. This gap is used, as described earlier, in order to limit the maximum flux density in the core and also to allow for some tolerance in the magnetic properties of the core material, which is Ferroxcube IIIB3. The operating frequency is approximately 3,000 c/sec., which is quite close to the frequency which gives minimum total loss.

The half-wave rectifier employs two 0A55 germanium diodes in series, mainly because their rectification efficiency is some 15 per cent. better than that of the comparable selenium rectifiers that could be used.

It will be noticed that the diagram indicates that both electromagnetic shielding and quite extensive filtering have been used, much as with a comparable vibrator converter. The reason is to be found in the existence of harmonics of the fundamental oscillation frequency, up to quite a high order. These extend into the broadcast band in spite of the relatively low oscillation frequency, and are rendered all the more necessary by the fact that the receiver, being a portable one, will certainly use a loop aerial, inevitably placed very close to the source of interference. Nevertheless, it is characteristic of the transistor converter that the interfering signals generated by it fall off rapidly in intensity with increasing frequency. At 35 mc/sec., for example, it has been found possible to operate a very sensitive super-regenerative circuit from the same kind of converter without any trace of interference, even when the oscillation frequency was of the order of 5,000 c/sec. If possible, the input and output filter condensers should be of the feed-through type of construction, and the shielding box into which the converter is built should be of heavy-gauge steel. The drawing of the circuit indicates that the input and output R.F. chokes should be housed in separately shielded compartments, so that they may not actually pick up interference from the main part of the circuit by induction, thereby defeating their own object.

A suitable type of lay-out for the converter is illustrated in Fig. 2. The steel box need not be deeper than is necessary to accommodate the OC15, which is mounted sideways on a small bracket, so that the completed unit will not be much more than one inch

deep. It can measure 4 in. x 3 in. x 1¼ in., which emphasizes its advantage in compactness compared with the dry batteries which it is designed to replace.

If the periods of use of the receiver are expected to exceed two hours or so, the current drain of 200 ma. is rather too large for the efficient use of dry batteries, and accumulators would be preferable. The advantages to be gained by as complete transistorization as possible are emphasized by the fact that if the above receiver were to use transistors in the A.F. stages, the power output of the converter could be reduced by at least 60 per cent., and the total battery drain by 50 per cent. At that, the set would be quite suitable, even for protracted periods of use, for powering from dry cells.

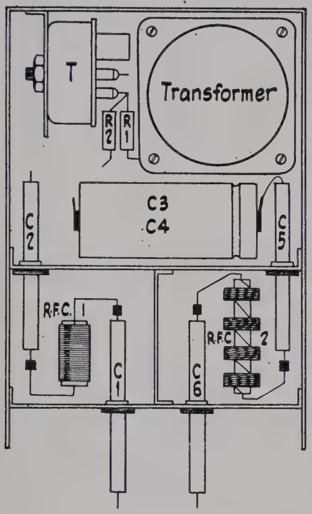

Fig. 2

OTHER EXAMPLES OF WORKED-OUT DESIGNS

The first example is one that has been suggested in the last paragraph. The design is based on an output of 70 volts at 5 ma., obtained from an L.T. battery of 6 volts. The output voltage and current both suit a receiver with an R.F. end comprising a DK96 frequency changer and a DF96 I.F. amplifier, while the 6-volt L.T. battery is ideal for a transistorized A.F. section comprising a pair of OC72s in the output stage, and two OC71s as driver and voltage amplifier. The filaments of the valves could be connected in series and fed from the 6v. supply through a dropping resistor.

The basic converter circuit is identical with that in the previous example, and its construction could be along similar lines also. The relevant details of the transformer and the circuit for these two examples are given in tabular form, together with those of an additional example which is about to be described.

The next example illustrates what can be done by way of extremely low-powered and minute converters suitable for powering existing valve-type hearing aids. The design is based on an output of 30 volts at 100 μamps. and an input voltage of 3. This example illustrates well how designs can be varied to suit a particular set of circumstances. The transistor used is an OC71, and in order to make it possible to use the smallest available type of Ferroxcube pot core—namely, the D14/8—the frequency has been raised to 12.5 kc/sec. This results in an efficiency of only 55.5 per cent., as against the more usual figure of around 70 per cent., but as the D14/8 core is so much smaller than the next largest pot core, the loss of efficiency has been regarded as unimportant compared with extreme compactness, for the aim here is to build the complete converter into a space no larger than the conventional 30-volt hearing-aid B battery block. The current drawn from the L.T. battery is only 1.8 ma. This shows the advantage of a transistor converter at its greatest, for this minute drain will in many cases be no more than about 5 per cent. of the total battery consumption. This means that, after transistorization of the B supply, operating expense is reduced to no more than the replacement of the old A battery, without any significant decrease in its life expectancy, the B battery having been eliminated.

The effect on the transformer of raising the frequency is twofold. In the first place, the flux density in the core is inversely proportional to the square root of the frequency. This enables a smaller volume of core material to be used without running into saturation; similarly, the number of turns on each winding is also inversely proportional to the working frequency, and this makes it practicable to get the required number of turns on the very small bobbin of the D14/8 core without having to use impossibly fine wire.

TABLE 1

Design and Performance Figures for the Three Sample Converters Discussed Above

Battery voltage	9v.	5v.	3v.
Output voltage	100v.	70v.	30v.
Output current	10 ma.	5 ma.	100 amp.
Input current	157 ma.	90 ma.	1.8 ma.
Frequency	3000 c/sec.	1300 c/sec.	12.5 kc/sec.
Efficiency	71%	65%	55.5%
Core type	D36/22	D36/22	D14/8
Air-gap	0.1 mm.	0.1 mm.	0.06 mm.
Primary turns	56	59	200
Feedback turns	25	17	25
Secondary turns	450	850	825
Transistor type	OC15	OC15	OC71
Peak collector current	500 ma.	355 ma.	5.8 ma.
Series base resistor	135 ohms	200 ohms	825 ohms
Material, Ferroxcube	$IIIB_3$	$IIIB_3$	$IIIB_3$

Note.—Air-gap in all cases is between both centre core and outer ring and one end-plate.

ELABORATION OF BASIC SYSTEM

All the examples given so far have used the same basic circuit, but there are some simple elaborations of this arrangement which are valuable in certain cases. An interesting modification is to use two transistors in a push-pull arrangement. The balanced circuit arrangement extends to the secondary windings and rectifiers, but it is not immediately obvious that the full-wave output arrangement is an essential feature of the circuit, until it is remembered that in the single-ended scheme the secondary must be correctly polarized with respect to the rectifier. If this is not done, the latter will rectify only the low voltage which appears across the secondary during the steady build-up of current in the primary winding. Thus, the push-

pull arrangement must have a separate winding for each half-cycle, and a separate rectifier, too.

The chief advantage of this circuit is that it enables twice the output power to be handled by the transformer, the reason being that the core is at its maximum flux density only at the moment when the peak collector current is reached. Because of this, the second transistor, working at the same frequency, but out of phase with the first one, is enabled to produce an identical peak flux density in the core at a time when the first one is cut off. From this, it should be obvious that the push-pull circuit can be designed on the basis of the simple circuit, merely by designing the latter for the required output voltage, but for **half** the required current. The only remaining question, then, is whether or not the bobbin will accommodate twice as many turns as the design indicates, since the design gives the numbers of turns for each half of the circuit. We have found in practice that it is sufficient to carry out the initial practical trial of the design figures by using only half of the circuit. Then, when the other half is added, all that happens is that the output current is doubled as well as the input current.

It will be noted that separate base series resistors are used for the two transistors. Both should be adjustable, and the proper way of setting up the circuit is as follows: A dummy load is placed across the output such that, at the correct output voltage, the current through it will be half the rated current for the complete circuit. One transistor is then disconnected, and the base resistor of the other is adjusted until the rated output voltage is obtained. The **input** current to the transistor is then measured and noted. Next, the other transistor is connected, the first being disabled, and the second's base resistor is adjusted until the input current is the same as was measured with the first transistor in operation. The procedure equalizes the average, and therefore the peak collector currents, thus ensuring that they share the load equally. If now both transistors are set working together, it will be found that, at the rated output voltage, exactly twice the current can be obtained.

The push-pull circuit is useful mainly because it doubles the power output that can be obtained when a given transistor type is employed. It does this by halving the peak collector current that would be needed in order to achieve the same output power with a single-ended circuit. At present there is a considerable gap between the collector dissipation ratings of the OC72, which is 45 milliwatts maximum, and the OC15, which is 2 watts. The use of push-pull OC72s effectively provides the same answer as would a new transistor rated at 90 milliwatts collector dissipation, and this could be important where minimum size and weight are important. In other cases, the main disadvantage of using an OC15, running very light, is merely that of its price, which is naturally higher than that of an OC72. Readers will be interested to note that we have recently had working in our laboratory a converter using two OC15s in the push-pull circuit, with a core type D36/22, which gives a D.C. output of 12 watts. Its output is actually 100 volts at 120 ma. This shows what can be done with existing transistors, and raises some interesting thoughts about what can be expected when higher-powered transistors still become available.

(To be continued.)

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P. H. Brans' Radio-tube Vade-Mecum, 12th Edition. (Chief Editor, Dr. J. A. Gijser).
From John F. Rider, Publisher, Inc., 480 Canal Street, New York, 13, N.Y., U.S.A.:
Basic Synchros and Servomechanisms, Vol. 1 and 2, by van Valkenburgh, Nooger and Neville, Inc.

Missing and Stolen Radios

Auckland:
Golden Knight, 5-valve, AC/Battery portable, serial No. 178333; green plastic cabinet 10in. x 6in. x 4in., slightly oval at ends; one tuning knob on each side at bottom front; round dial centre front; ivory coloured carrying handle across top; switch at rear; complete with batteries.

Bell 7-valve portable, serial No. 8486; white plastic case with carrying handle missing from top; four control knobs.

H.M.V. battery/electric portable, maroon plastic case.

Taupo:
Ultimate battery/electric portable, serial No. 167544; dark maroon plastic cabinet.

Whitianga:
Five Star portable, serial No. 38435; red metal case with six feet of flex and three-pin plug attached.

Tauranga:
Autocrat 6-valve 230 or 6-volt DC car radio, serial No. 18731; grey cabinet 10 in. x 11 in. x 5 in., with two control knobs on each side of oblong dial fitted in centre of radio.

Whakatane:
Colombus 6-valve broadcast Exeter model radio, serial No. 33816.

Wellington:
Philips 5-valve AC/DC/battery portable radio model 546, serial No. 76768; maroon cabinet.

Mullard model 627, serial No. 64465/18985; brown wooden cabinet 18 in. x 12 in. x 12in.

No. 6: Internal Resistance of Dry Batteries (Cont.)

Last month we stressed the importance of internal resistance,, especially that of radio B batteries, where it can have serious effects on the performance of receivers, and in particular on the end-point voltage to which a set of batteries can be used with a given receiver. It is thus important for designers of battery sets to take its effects into account, and to find out in advance whether a circuit will operate properly with batteries whose internal resistance has increased with age.

One way of doing this is to keep a special set of test B batteries that have been discharged to the required end-point voltage **by normal use.** This is not as easy as it sounds, and a set of batteries which have been discharged in any other way will not have the required characteristics. For example, discharging a fresh battery quickly to the end-point voltage by imposing a heavy current drain, or employing longer than normal spells of duty in the process, results in a much smaller internal resistance than one which has been discharged over a long period at its normal output current, and in normal working periods.

The best solution to this problem is to simulate run-down batteries by means of external resistance in series with fresh ones. For this purpose, a series resistance of 330 ohms per 22½-volt section is recommended. When some parts of the receiver are supplied from taps on the B battery, the added resistance must be distributed between the sections of the battery, because if only one resistor is used, at either end of the whole battery, the effect is not the same as when the receiver is powered by a genuinely run-down set of batteries. For example, if the total voltage is 90, and some parts of the set are powered from a tap at 67½ volts, the circuit of the test battery should be as illustrated in Fig. 1. It should be remembered, too, that, when checking the voltage actually supplied to the set by the test battery, the measurement must be made between the negative terminal and the points marked with voltages in inverted commas, and then only when the set is drawing current. Figure 2 shows the circuit of a 67½-volt test battery which can be made up in a box and provided with terminals as shown, and then used to simulate run-down batteries with nominal voltages as shown. If a two-position three-pole switch is added, so as to short out the series resistors at will, the two switch positions can be marked "New" and "Flat"; the arrangement will then be suitable for testing sets under both battery conditions.

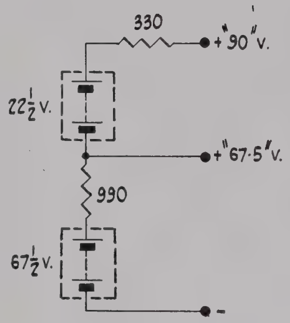


Fig. 1

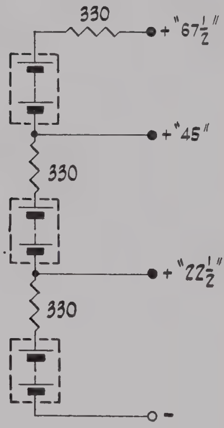


Fig. 2

It is suggested that this would make a very useful set-up not only for designers, but also for servicemen who do any quantity of work on all-dry portables or A.C./battery portables.

MEASURING INTERNAL RESISTANCE

An accurate measurement of internal resistance by D.C. methods is difficult to make, and requires special gear, but a method which has been found to give results consistent with the behaviour of batteries in actual use is to pass a known alternating current through the battery and to measure the alternating voltage across it with a V.T. voltmeter which responds only to A.C.

Gisborne:

Courier 5-valve, "Cygnet" model radio, serial No. 177765, mantel model; grey plastic cabinet.

Radiola 5-valve mantel clock radio with electric clock set in centre of radio dial; serial No. 51193. Cream plastic case.

Lower Hutt:

Ultimate portable radio, serial No. 168–028; brown cabinet with white plastic handles and gold coloured dial.

Upper Hutt:

Gulbransen 1937 all-wave mantel model 7-valve radio with magic eye; wooden cabinet.

Christchurch:

Philips 5-valve portable radio, serial No. 1578; maroon plastic cabinet with two white knobs on front.

Colombus portable radio in brown leather cabinet 16 in. x 10 in. x 8 in., with pale green dial.

Pacemaker portable radio, serial No. 31054; blue and white cabinet 15 in. x 12 in. x 8 in.

Clipper 8-valve auto radio, serial No. 60043; radio in three parts, power pack, tuning unit and aerial.

Philips 5-valve AC/DC portable radio, model 546; Philips speaker with "Ticonal" magnet built-in loop aerial, maroon moulded cabinet 9½ in. x 10¼ in. x 4½ in.; weight 7 lb. 12 oz., complete; plastic cabinet with perspex dial and four control knobs. Serial No. 85520–131264.

National 5-valve, battery, portable; cabinet 9 in. x 12 in. x 9 in. with grey plastic front and back and blue metal sides; two control knobs with switch under control handle.

Dunedin.

H.M.V. "Personal" portable, serial No. 10785.

Mullard table model radiogram, model 520A, serial No, 29557; wooden cabinet.

Radiogramophone

The "R. & E." High-quality Nine—Part II

DESIGN OF THE TUNER

Since the synchrodyne created such a stir, it can be said with some truth that the problem of high-fidelity broadcast reception has been solved, and that except for possible minor improvements, the synchrodyne gives a virtually perfect answer. Unfortunately, however, it cannot do the impossible; this means that its overwhelming advantages over conventional tuner systems can be used only where conditions are right for it. For example, it cannot give high-quality results from a poor signal—one which is garbled because of fading and selective distortion. The synchrodyne cannot be any better than the signal it has to work on, and this means that its advantages occur only in those areas where a perfect signal is available. For districts where there is only one local station, and that not on for the full broadcasting day, it is somewhat uneconomic, because it would have to be supplemented by a more conventional tuner, whatever the tastes of its owner. Thus, a set like this one cannot but use a more conventional tuner, and one of the simpler schemes for obtaining broad-band reception must be used. For economy and excellence of results, where properly put into practice, few schemes can compete with the use of a conventional superhet circuit with I.F. transformers having two or more degrees of selectivity. This scheme adds little to the tuner by way of complexity, and yet does give a very significant improvement in quality. It has the further advantage that the extra bandwidth and high-note response can be used when listening to distant stations, provided the signal is strong enough, and is not suffering for the time being from selective fading. By using this sort of tuner, therefore, it is possible to have if not the best of both worlds, at least a good deal better final answer than can be had from any ordinary set. Those who read last month's article on the alignment "wobbulator", will remember the photographs showing the frequency response of a properly over-coupled I.F. amplifier. This was an experimental circuit, built up only to illustrate the use of the "wobbulator", but it did demonstrate that it is possible to obtain a bandwidth of almost 20 kc/sec. in a 455 kc/sec. I.F. stage. If this performance can be realized in an actual set, then the response of the whole set in the "Local" selectivity position will extend almost to 10 kc/sec., before it departs significantly from flatness. Unfortunately, it is a good deal more difficult to achieve in a receiver what can easily be done in a laboratory experiment, but the results that have been obtained with the tuner of this set have been most gratifying, and there is little reason why readers should not be able to duplicate them, with a little careful work.

We have often been asked why it is that none of the broad-band tuners which we have designed have made use of a stage of R.F. amplification. The reason is that it is difficult enough to preserve the proper type of R.F. response curve for high-quality results, even when only one tuned circuit precedes the mixer valve in a superhet. The reason for this difficulty is to be found in the necessarily imperfect tracking that takes place in the signal circuits of a superhet, allied to the fact that the R.F. circuits provide a certain amount of selectivity, whether we want it or not. In this case we certainly do not want it, because it varies according to the part of the broadcast band we happen to be in, at the very same time as the tracking of the R.F. circuits vary. These things make it very difficult to obtain satisfactory results over the whole broadcast band. For instance, if a set is carefully adjusted for the best possible results on one station, results will be anything but optimum on most other frequencies within the band, and this is highly undesirable. The more tuned circuits there are in the R.F. section of the set, the greater the difficulty of obtaining consistent results over the whole band, and this explains why we have hitherto avoided the use of R.F. amplifier stages in tuners with broad-band response. Here, however, it was felt that in catering for poor reception localities, a stage of R.F. amplification would have to be included, and its selectivity simply put up with when it came to local reception. However, on commencing to think out a suitable valve line-up, the E.F.85 and its characteristics struck our eye. This valve is one with rather an unusual combination of characteristics. It is a variable-mu tube, but has a high mutual conductance—rather more than twice that of normal variable-mu tubes—and has been designed especially for use in European countries, where combination A.M./F.M. sets are becoming more and more the rule rather than the exception. The reason for this is the growing use of very high frequencies, frequency-modulated, as a means of obtaining good reception now that the long and medium-wave bands have become almost impossible except in the immediate vicinity of high-powered broadcasting stations. This trend is being followed in the United Kingdom too, where the B.B.C. is just starting its programme of V.H.F. broadcast coverage as an alternative to the ordinary broadcast band.

The development of combination sets, working on two such widely different frequency bands at the turn of a switch, has brought about a requirement for a tube such as the EF85, which can act as an R.F. amplifier at frequencies of the order of 100 mc/sec., and still be used on the broadcast and long-wave bands. This valve suits the present purpose admirably. If, however, any attempt were made to use the maximum stage gain that the EF85 would appear to make possible, there would almost certainly be difficulty in achieving stability, particularly at the high-frequency end of the band. Moreover, even if the stage did not actually oscillate, regeneration would certainly prevent the broad-banded I.F. stage from producing the desired effect on the over-all selectivity curve of the receiver. Fortunately, it is always possible to trade gain for bandwidth, so that by damping both the R.F. and mixer grid circuits with resistance, it is possible to obtain the doubly desirable effect of increasing the

bandwidth of the R.F. section and at the same time reducing the gain to manageable proportions. In this way, we finish up with an R.F. stage which has as much signal amplification as a conventional one, but much greater bandwidth. It should be noted, though, that this comes about only because a valve has been used which has a greater mutual conductance than usual. If the same scheme were attempted with a conventional R.F. pentode, the bandwidth would be secured, but the stage gain would be much smaller than usual.

The I.F. stage is broad-banded by the popular method of switching in small tertiary windings in each I.F. transformer in order to increase the couplings between windings. It is possible to purchase I.F. transformers of this sort ready made, but the advantage of taking standard transformers and modifying them by adding one's own tertiary winding is that the degree of over-coupling can then be chosen independently of the maker of the transformer, who can only provide that degree of over-coupling which he thinks will suit the majority of applications. In other words, we can make the bandwidth in the "broad" position wider than can be obtained with commercial two-point selectivity I.F. transformers.

In most respects the tuner is quite conventional, in that no trick circuits or special dodges are employed. Perhaps the most unusual feature is the use of a crystal diode as the A.V.C. rectifier instead of one of the diodes in the EBF80. In a dual-purpose tuner like this one, where fairly high sensitivity is wanted at least part of the time, it is good practice to use a high delay voltage on the A.V.C. diode. There are two main reasons for this. The first is that the combination of high sensitivity and large delay voltage makes for excellent A.V.C. action, the output from the detector rising only very little once the A.V.C. has started to take effect. The other reason is that when a large delay voltage is used, the signal voltage at the detector is also large, and this makes for distortionless detection, which is a very important consideration in sets which attempt to give high-quality reception, through an excellent amplifier and speaker.

The reason for using the crystal diode as the A.V.C. rectifier is to enable a large delay voltage to be used without putting in a separate double diode valve. The commonest way of arranging for a voltage delay on the A.V.C. diode is to use cathode bias on the double-diode-triode (or pentode) valve, then returning the A.V.C. load resistor to chassis. The positive potential developed across the bias resistor then becomes also the A.V.C. delay voltage. This principle does not allow the delay voltage to be chosen independently of the bias voltage on the valve containing the diodes, and so prevents a large delay from being used. The delay in this circuit can be made as large as we please, and a figure of 6 volts has been settled upon. The end of the crystal diode which corresponds to the cathode of an ordinary diode is connected to the tap on a voltage divider made up of 270k. in series with 5k. at the lower end.*

**The circuit diagram shows* 10k. *for this resistor, and should be amended accordingly.*

The valves used in the R.F. end all need a minimum bias of —2 volts. This has been obtained by back-bias. Reference to the power supply section, which is on the same diagram as the audio amplifier, will show a 22 ohm resistor connected between the centre-tap of the power transformer and earth. The whole set current flows through this resistor, producing approximately 2 volts drop across it when the receiver is not tuned to a signal. With a strong signal applied, the set current decreases, and with it the potential across the bias resistor, but at such a time, it is of no consequence, because there is a large A.V.C. bias on the valves. Some readers may be surprised to note that there is no electrolytic bypass condenser across the back bias resistor, and that the filter input condenser is not returned to the centre-tap of the transformer instead of to earth. These precautions are usually necessary when back-bias is used, because the back bias resistor is usually much larger, and so a considerable hum voltage is developed across it unless suitable precautions are taken. Here, however, the back bias resistor is so small that a negligibly small hum voltage is developed across it, and the usual precautions have been found not to be needed.

SOME CONSTRUCTIONAL POINTS

The working drawing for the chassis was given in the first instalment of the article, but no mention was made of the arrangement of the parts on it. The output valves are placed one on each side of the output transformer, which is at the back of the chassis near the left-hand corner. In front of the output transformer are the two B309s belonging to the audio amplifier, the first of these being quite close to the front of the chassis. In order to follow the lay-out further, a knowledge of the positions of the controls is necessary. At the extreme left is the selector switch for Radio/Gram and the other functions that have already been described. Next to the switch is the volume control, followed by the bass and treble tone controls, in that order, and finally, at the extreme right, the tuning control. On top of the chassis, in the left-hand front corner, is the socket which takes the lead from the pick-up, and very close to it is the pre-amplifier valve. At first sight, this lay-out appears to spread out the audio section a good deal, and so it does, but the unconventional arrangement does not prejudice the proper working of the amplifier or result in hum pick-up. It is really important to have the pre-amplifier valve as close as possible to the switch, because the latter is in this tube's grid circuit, but the spread-out arrangement of the controls and other parts in the tone-control network has no ill effects, because the signal level at the input of the network is quite high. No baffle shielding for this part of the circuit was found necessary, although space was allowed for it should it have turned out to be needed.

The R.F. end of the circuit is quite compact, and is grouped round the gang condenser in the usual way. The I.F. transformers can readily be recognized in the photograph, with the I.F. amplifier valve between them. It should be noted that this valve is almost directly behind the selector switch, and there is a purpose in this. Reference to the under-chassis photograph will show that one wafer is placed right at the back end of the switch, while the other is near the front in a strategic position for use in the 78/L.P. portion of the circuit. The back wafer is placed near the I.F. transformers, for it is used to switch the tertiary windings on the transformers to give the variable-selectivity feature. It may seem dangerous to have leads from both I.F. transformers coming fairly close together on the switch, but it is not bad practice in this instance, because the switching takes place at a very low impedance, which means that the signal voltage on the leads brought to the switch is very small indeed. Of course, there are two switches on each wafer, so that by mounting the switch in the normal way—i.e., with the rods in a plane parallel to the chassis—one each of these is brought quite close

to one of the I.F. transformers. Thus the leads from the transformers are not very long, nor do they approach each other at all closely.

THE I.F. TRANSFORMERS

Most builders will want to use ready-made variable-selectivity I.F. transformers, but those who may like to try for more bandwidth than these will give can quite easily do as was done in the prototype, and modify two conventional I.F. transformers by adding the tertiary windings themselves. These windings consist of only 15 turns of fine wire. They are wound as close as possible to the **upper** coil of the transformer and connected in series with the **lower** coil to increase the coupling between them, and thus broaden the response. The bases of the transformers used had six eyelets moulded into them, but only the four at the corners were used by the original maker for terminating the four ends of the two windings. The first part of the job after getting the transformer out of its shield box is to identify the low-potential end of the secondary and to disconnect the fixed tuning condenser from it. The condenser lead is then terminated on one of the spare eyelets by soldering a piece of solid wire into it to act as a lead to the switch, on the outside of the transformer, and as a tie-point for the condenser lead inside the can. One end of the wire for the added winding is soldered to the terminating wire of the cold end of the secondary that has had the condenser disconnected from it, and the new winding is put on. The important thing about this is to ensure that it is wound **in the same direction as the winding with which it is in series.** This ensures that the additional coupling is adding to the existing inductive coupling, and not counterbalancing it. The free end of the added winding is then terminated in the eyelet that is still vacant.

The lead from the fixed tuning condenser is then wired to the common lug of the switch, and the two coil ends are taken to the switch so that the condenser can be connected either to the end of the original winding, or to the free end of the added winding. The procedure is the same for both transformers, which are modified in exactly the same way. Care must be taken to ensure that both transformers are connected in the same manner when the switch is in one position. That is to say, one transformer must not be on "broad" when the other is on narrow.

In the selector switch there are three wafers, and so far the functions performed by the middle one have not been mentioned. On this wafer, one switch turns on the H.T. to the tuner for the radio positions and off for the gram positions, effectively preventing any break-through of radio signals when on "gram," while the other switches the volume control from the detector circuit, on the radio positions, to the output of the pre-amplifier tube on "Gram."

The R.F. amplifier valve is the one to the left of the gang condenser, and near the front of the chassis, while the mixer valve is in line with the I.F. transformers and the I.F. amplifier valve. The smoothing choke is to be found in the under-chassis view, directly behind the selector switch.

As an aid to stability, the front section of the gang and the coil beside it make up the aerial tuning circuit, while the mixer grid is the one at the back. The oscillator coil and tuning condenser are the middle ones. This arrangement is a good one, for it separates, as far as possible, the aerial and R.F. tuned circuits. The oscillator circuit, being on a different frequency and not being directly in the chain of signal amplification, is thus able to act as an effective shield between the two.

NOTES ABOUT NEW BOOKS

VACUUM VALVES IN PULSE TECHNIQUE

By P. A. Neeteson. (Published by Technical and Scientific Literature Department of N.V. Philips' Gloeilampenfabrieken, Eindhoven, Nederland. New Zealand distributors, Philips Electrical Industries of N.Z. Ltd., P.O. Box 2097, Wellington. PRICE 27s.).

The use of electronic valves in electric circuits has spread within the last few decades over a vast new field, the field of pulse technique. Here, there are two distinct operating states, in one of which no, or very little current is drawn and the valve is cut off, while in the other heavy anode current flows and the valve is fully conducting. The change-over occurs suddenly and is accompanied by certain related switching phenomena in the network; the valve operates as a "switch".

Although there are many familiar applications of this, the essential characteristics of the switching phenomena are still a closed book to many users.

It is the main aim of this work to indicate how the behaviour of a network in which electron valves are used as switches can be studied with a view to more efficient use, and new applications. After introductory chapters on the opening and closing of switches in networks and some principles of operational calculus, there follows a thorough study of the vacuum valve as switch. This is sub-divided into a treatment of the grid circuit and of the anode circuit, both for the triode and the pentode. The last chapters deal with three very important and widely used circuits—the bistable, monostable and astable multivibrators.

This book was actually prompted, we understand, by a problem which arose in practice and which demanded a deeper investigation by the author of the dynamics of one of these pulse circuits. As a result, the operation became easier to understand and special valves were developed having particularly favourable properties for pulse techniques.

INTRODUCTION TO TV-SERVICING (For 525 and 625 Line Receivers)

By H. L. SWALUW and J. VAN DER WOERD. (Published by Technical and Scientific Literature Department of N.V. Philips' Gloeilampenfabrieken, Eindhoven, Nederland. New Zealand distributors, Philips Electrical Industries of N.Z. Ltd., P.O. Box 2097, Wellington. PRICE 40s.).

While we still await the introduction of a TV Service in New Zealand, enterprising servicemen are anxious to prepare themselves against the problems ahead when a TV service is established in this country.

This book has been written specially for those radio-service technicians who, having a sound knowledge of circuit fundamentals and practical experience, wish to prepare themselves for TV servicing. The material is presented in such a way that most radio servicemen will have no difficulty in following the reasonings and explanations, and will quickly grasp the procedure required for adjusting the internal and external controls of the TV receiver, for making mechanical adjustments and for carrying out simple repairs. This is the more important because simple faults account for more than 50 per cent. of the total faults which occur in TV receivers, and it is possible for trained servicemen to effect repairs with the aid of a limited amount of test equipment in the customer's home.

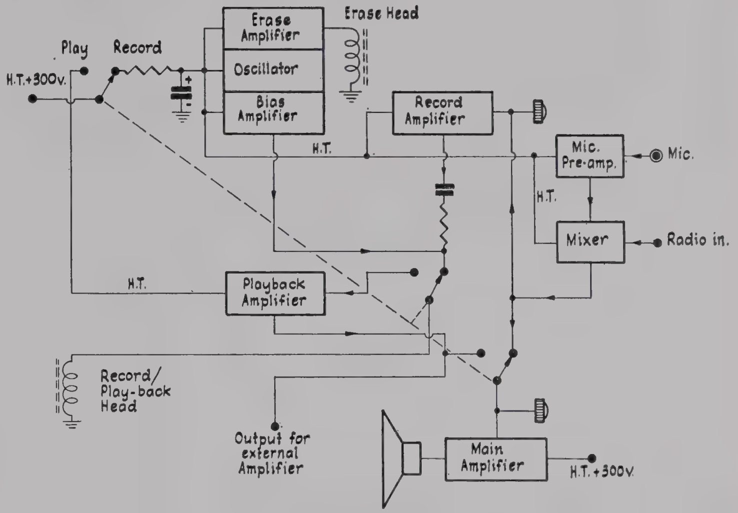
Before proceeding with a discussion of practical problems, a theoretical introduction is given, consisting of a short explanation of the scanning system, of the working of the picture tube and of the waveform of the TV signal, followed by an extensive description of a modern TV receiver with separate sound channel (split-sound receiver). Chapters are then devoted to two modern developments, intercarrier sound and turret tuner with cascode amplifier.

(Continued on page 51.)

Recording

CIRCUITS FOR MODERN TAPE RECORDING

PART 4—THE COMPLETE SYSTEM



In the three parts of this series that have gone before, we have described the circuits needed for a complete tape recorder and playback unit, in which there is no duplication of functions. That is to say, each valve has only one job to perform, and one only, so that every circuit is self-contained, and includes no dual-purpose switching arrangements.

This system is rarely found in commercial tape-recorders, because it does lead to the use of a fairly large number of valves and to a greater quantity of circuitry than otherwise. Functionally, however, it is not only the simplest but also the best possible way of designing a recording and playback equipment. It enables each part of the circuit to be designed without reference to the others, and so each part can be made to have the best possible performance for its own special function, without compromises introduced by the fact that special circuit changes must be made in order to make the same valves work both as playback pre-amplifier and recording amplifier, for example.

From the point of view of the builder, however, one of the best features of this type of construction is that the switching is simplified very considerably. As a direct result of this, the input and output of the same amplifier do not have to be brought close together at the switch, and this means that a very prolific source of trouble is eliminated altogether. When the same basic amplifier is used for both recording and playback, both input and output have to be brought to the switch, as do several intermediate points on the circuit, in order that the response curve of the amplifier may be altered to suit the function of the moment. This sometimes makes stability very difficult to achieve, because the overall amplification is quite high, on both playback and record. The purpose of this final instalment of the series is to show how the separate circuits that have been described in earlier ones are integrated into a complete system.

INTER-CONNECTION AND SWITCHING

The block diagram shown on this page gives the complete set-up using the units that have already been described. Alternatively, it can use any other circuits that are considered suitable for the individual functions. The diagram looks rather complicated for a block diagram, but this is because it is really a switching diagram, than which nothing could be very much simpler. The signal paths on both record and playback have been shown as to direction by means of arrows on the wiring, and the H.T. lines to all units have also been included. The sum total of switching comprises only three two-position switches ganged together. One pole takes the 300-volt H.T. line and distributes it to either the playback amplifier or the record and bias circuits. A second pole connects the record/playback head either to the input of the playback amplifier or the output of the record amplifier, and the third pole connects the input of the internal speaker amplifier either to the output of the playback pre-amplifier or to the output of the recording mixer circuit. Also shown in the diagram are the positions of the two gain controls, one for record and the other for playback. The record gain control is between the mixer and the record amplifier, and presupposes that neither the microphone pre-amplifier nor the mixer will be overloaded by any signal that they are likely to receive. This assumption is quite well justified, because, in the case of the former, avoidance of overload simply means using the sort of microphone for which the circuit is designed. As far as the mixer is concerned, this circuit is a cathode follower, which will accept signals up to several volts in amplitude.

Both signal inputs are intended to receive signals whose frequency response is flat. The one labelled "Radio In" will accept the output of any radio receiver or flat amplifier. If it is desired to record directly from a gramophone pick-up, it should be remembered that things will not sound right unless the pick-up is properly compensated before being fed in. It is best, therefore, to come out of the pick-up pre-amplifier in which the response is compensated, but, if it is more convenient, there is no reason why the input should not be taken from the voice-coil winding of the main gramophone amplifier. The disadvantage of this procedure is that there is then no control over the volume coming from the speaker of the record-playing amplifier, since the latter's gain

control may have to be advanced too far for comfortable listening, in order to obtain enough level in the recorder, to fully swing the magic eye. If the microphone is not in use simultaneously, this can be overcome by feeding the signal into the microphone pre-amplifier, after first attenuating it so that there is no danger of overloading the pre-amplifier valve. A voltage divider connected across the voice-coil of the gramophone amplifier can be arranged so that, with a suitable listening level from the speaker, the output from the voltage divider is small enough not to overload the pre-amplifier valve. After the listening level is set, the record gain control can be used to adjust the recording level without alteration to the volume control on the gramophone amplifier.

The only part of the block diagram that has not been described in the present series of articles is that labelled "Main Amplifier." This is merely the internal power amplifier for working the built-in monitor speaker. Of course, this amplifier and speaker can be left out if desired, but, if the recorder is to be transportable, they are essential. However, where the amplifier is to be built into an existing sound system in the home, for example, they can be omitted and the input of the external power amplifier connected to the switch in place of the amplifier shown.

One small point that is emphasized by the diagram is the necessity for a delay network in the H.T. feed to the bias circuits. This is the CR circuit shown in the H.T. feed to these components. Their purpose is to ensure that the H.T. voltage cannot be suddenly removed from the record and erase heads, leaving them partially magnetized, as would happen if the bias waveform was cut off short at any but the zero of the cycle. As it is, the oscillator and amplifiers cannot stop working suddenly, but will do so slowly, as they gradually empty the charge from the electrolytic condenser after the H.T. has been switched off. In this way it is ensured that the heads are left demagnetized.

RADIO CLASSES

For Operators, Engineers, Servicemen, commence on 1st February, 1956. Enrolments received now.

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Introducing the NEW
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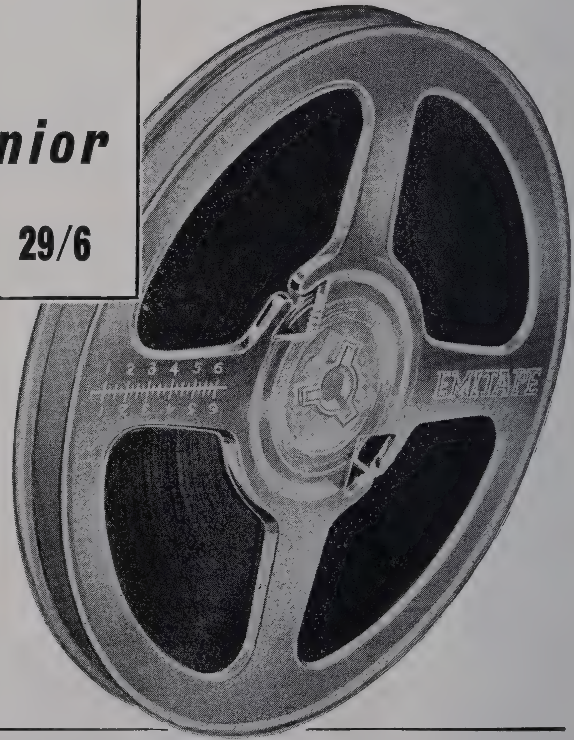
MAGNETIC RECORDING TAPE
5″ REEL 600 ft. Price 29/6



The popular Emitape '88' is now available in a convenient 5″ spool of 600 ft. length, suitable for recordings of up to one hour. This spool is identical to the larger 7″ (88/12), will fit all tape recorders, and is suitable for single or twin trackings. In addition it has a metallic contact strip to operate on machines fitted with auto-stops.

Emitape is unequalled for fidelity of recording and reproduction as well as for strength and length of life. It is used for recording by "His Master's Voice", Columbia and Parlophone. Emitape is also used by the world's leading broadcasting and other recording organisations.

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E.M.I. SUPPLIERS
(Trade Division of H.M.V. (N.Z.) Ltd.)
P.O. Box 296 162-172 WAKEFIELD STREET, WELLINGTON Phone 54-890

RECORD TALK

by JOHN GRAY

An intriguing item from H.M.V. is a harpsichord recital by that grand old veteran Wanda Landowska, who was for many years one of the few internationally known players of this fascinating instrument, which has a huge literature, nowadays generally played, if at all, on the piano. This is, however, an age of both scholarship and purism where old music is concerned, and if the harpsichord is enjoying something of a revival it is largely due to Madame Landowska's pioneering efforts. Before the war she made fine records, usually under "Society" auspices, of Handel, Scarlatti, Bach, and Couperin. All these are represented on her new recital disc (ALP 1246) also a sparkling concerto of Vivaldi's arranged by Bach, and short pieces by other eighteenth century masters. For those uncertain as to whether they really like harpsichord music—and I have heard some devastating comments by those who don't—this disc should prove an admirable sampler. If you like it, you may then be moved to investigate the colossal set of Couperin's harpsichord works recorded complete by Ruggero Gerlin on sixteen discs! (Osieau Lyre, OL 50002-57).

There is nowadays a tendency to stretch LP to its utmost limits, thus many new issues offer nothing if not your money's worth. A case in point is ALP 1245, whereon Charles Munch conducts the Boston Symphony in an unusually generous programme of French music. Besides two quite large works by Ravel, the fascinating "Rapsodie Espagnole" and the brilliant "La Valse", the record contains three overtures; Lalo's powerful "Le Roi d'Ys", Saint Saens' "Yellow Princess" and Berlioz' "Beatrice and Benedict". There is more from Toscanini, whose stock of recordings is obviously far from being exhausted. Dvórak's "New World" symphony receives one of the finest performances it has yet had on discs (ALP 1222) and Toscanini enters a congested field with yet another version of the Moussorgsky-Ravel "Pictures at an Exhibition" (ALP 1218) adding, as a makeweight, Cesar Franck's "Psyche and Eros". Another orchestral disc, more interesting in that it offers something fresh, is CLP 1044 containing Prokofieff's seventh symphony, one of his last works and one of his most immediately attractive. I should urge this on all who normally fight shy of modern music, for Prokofieff, even in his wildest moments, has never forgotten that the basis of all music is melody, and this work is beautifully played by the Philharmonia under Nikolai Malko, with the composer's popular "Classical Symphony" thrown in for good measure.

Once again there are interesting releases for opera lovers, who have been almost too well served in these latter years. Verdi's "La Forza del Destino" on three new Columbias, 33CX 1258-60, is an opera which I would place in the first half dozen by this prolific composer. The plot is complicated and melodramatic enough to antagonize any of the anti-opera faction, but Verdi's inspiration was at fever pitch almost from first note to last, page after page of glorious music pouring forth with never a suggestion of flagging. This atmosphere of excitement has been well caught in an "all out" performance by the company of La Scala under Tullio Serafin. The prima donna is once again Maria Callas, never failing to hold our attention despite her odd vocal inequalities, and we have a splendid tenor and baritone in Richard Tucker and Carlo Tagliabue, who have no fewer than three superb duets in the course of the opera. Both give all they have, perhaps the more astonishing performance being the baritone's, for by now he is, literally, an old man, and his singing bears the stamp of years of training and experience whilst sounding entirely adequate. Rossi Lemeni, who seems to have an embargo on the bass roles in Columbia's opera recordings, gives a more consistent performance than usual. The opera is not quite complete but the three discs are well filled and I rank the issue as altogether the most exciting Italian release of the year: the music is Verdi at his greatest and the recording quite satisfying. Then there is "Othello", which we thought had been given a "once and for all" performance on H.M.V. by Toscanini. It now appears on Decca LXT 5009-11, with the well tried team of Tebaldi and del Monaco in the leads. Frankly the choice would be extremely difficult, though the Decca unquestionably wins as a recording. Let us count ourselves privileged to have two such sets to choose from.

Opera of a different sort is provided with "Princess Ida" (Decca LK 4092-3) which comes presumably as the last of the long Gilbert and Sullivan series, for all that are left now are "Utopia Limited" and the "Grand Duke". No hope of getting these, I daresay, though the catalogues are peppered with works, including operas, by all sorts of obscure composers. Somehow I cannot help wishing Decca would indeed come to the rescue, for the two works mentioned are never heard in the theatre and I cannot believe that Gilbert and Sullivan's inspiration had dried up completely by the time they came to write these last two, especially when we consider that they were immediately preceded by "The Gondoliers", which was one of the best of all. Meanwhile we may welcome "Princess Ida", containing as it does a wealth of fine melodies and which, unfortunately, is very rarely given when Gilbert and Sullivan companies choose to visit us. Before leaving the subject of opera I must mention a London disc, TWV 91053, of a recital of arias sung by the famous soprano Claudia Muzio (1892-1936) whose comparatively early death was, to use a stock but convenient phase, a great loss to the world of opera. A number of electric recordings by this artist used to grace the Columbia catalogue, but this new London is taken from acoustics made in the early 1920s when her voice was at its freshest. The arias are heard, needless to say, through a fusilade of surface noise which the dubbing process has failed to eliminate, but it is surprising how quickly one becomes used to this and, besides many well known numbers, there are some rare ones, from Giordano's "Madame Sans Gene" and Bellini's "Bianca e Fernando". Such an issue shows enterprise and it is to be hoped that it will receive the support of all who profess to admire great singers of the past.

Two more Columbia sets are of interest, and one breaks fresh ground. Entitled "Le Group des Six" it features representative compositions by each of the six French composers who banded together as a sort of club in the early 1920s. Their real leader was another composer, Erik Satie, their mouthpiece the author Jean Cocteau, who contributes a verbal introduction to this recording, which could well have been left out, firstly because it is naturally, spoken in French and secondly because a full translation is provided on the cover anyway. The music is interesting: a bucolic overture by Germaine Tailleferre, a very moving work for strings by Honegger, a set of choral songs amusingly called "Drynesses", by Poulenc, a rather pale song for soprano and orchestra by Durey, a large, modern, but not extreme ballet score by Auric, and a symphony by Milhaud. All these are well conducted by Georges Tzipine (33CX 1252-3). Mahler's deeply moving ninth symphony is played by the Israel Philharmonic Orchestra under Kletzki on 33CX 1250-1. By making a large cut in the second movement, which annoys extreme Mahler fans more than it does me, the conductor has managed to accommodate the symphony on three sides, leaving room for Schonberg's "Transfigured Night". This is very early Schonberg and precedes his atonal period—a thoroughly rich and satisfying piece of music.

Mahler is also to the fore in the Philips list, in a new issue of the Symphony No. 1 in D major, magnificently played by the New York Philharmonic-Symphony under Bruno Walter, the doyen of living Mahler conductors and himself a friend and associate of the composer in his early Vienna days (ABL 3044). Philips deserve commendation, too, for bringing out Stravinsky's opera-oratorio, "Oedipus Rex", in a definitive performance under the composer's direction (ABL 3054). Composed in the midst of his neo-classic period, this work is well done by the orchestra and chorus of Cologne Radio, with Marthe Modl and Peter Pears among the soloists. A new disc by Sir Thomas Beecham revives, for the first time in many years, one of the most pleasant sets of orchestral variations in existence, Dvorak's "Symphonic Variations", the general neglect of which is quite unaccountable. It is backed on ABL 3047 by Balakireff's graphic tone poem, "Thamar". Among the lighter Philips' offerings are many entertaining records, a set of English folk songs nicely sung by the tenor Murray Dickie (NBR 6016), the original sound track of Judy Garland's film "A Star is Born" (BBL 7007) a colourful Liberace disc entitled "Concertos for You" (BBL 7030) and a whole group of jazz LPs, from which one might single out collections by the Dave Brubeck Quartet (BBL 7018) and Lionel Hampton's Orchestra (BBL 7015). Descending to the pop singles we find Kostelanetz conducting "Strike Up the Band" and "Stars and Stripes" (B 21039), the whistler Ilse Werner in "Jungle Drums" and "The Breeze and I" (B 21659), Johnnie Ray letting off steam with "Ooh Aah Oh!" and back to his sobs in "It's the Talk of the Town" (B 24528). A good corrective to this can be found in another of Digits Malloy's Ragtime medleys, which is on P 37029. Best of all, to my way of thinking, is Mitch Miller's rousing version of "The Yellow Rose of Texas" on B 21688. This "latest hit" is something like a hundred years old, having been one of the favourite songs of the Confederate armies, and in itself provides depressing evidence of how the popular song has deteriorated. Apart from its march ryhthm, its sentiment is open, hearty and healthy, a magnificently extrovert song which comes as a breath of fresh air after much of today's moaning and snivelling. It is also a real tune. So there!

Festival offers a disc of "organ and piano" playing by one Julian Gould on CFR10-741. I am not sure what this implies but the titles include several tried old favourites. Otherwise, their latest list offers a number of interesting classics. The Brahms piano sonata in F minor, for instance, is played on Westminster WL 5245 by another outstanding representative of the younger school of pianists, Paul Badura Skoda, who is due in Australia,

(Continued on page 51)

ELECTRICAL AND TRADE SECTION

STEAM IRONS

(Reproduced by courtesy of "The Domestic Equipment Trader," June, 1954 number.)

It is new products which really put the zip into selling, and it is no exaggeration to say that the domestic iron market has received just such a fillip with the arrival of the new lightweight steam irons.

Although steam irons have actually been in existence for a number of years they have been sold almost exclusively for commercial use, and are only now beginning to take their proper place in the domestic appliance world—in much the same way that food mixers suddenly emerged from the background in the U.S. market and became a best seller. Some of the sales people who have had the opportunity of handling steam irons sales put the eventual proportion of the domestic iron market which they will absorb as high as fifty per cent. In view of the fact that the steam iron is really two irons in one, this may well prove a reasonable estimate.

To sell a product well you must understand it thoroughly, so here is a brief description of the two types of steam iron and how they work. Afterwards we give some itemized pointers on selling this product.

HOW THEY ARE MADE AND HOW THEY WORK

Steam irons may be divided into two types: (1) the drip-feed and (2) the kettle type.

Drip-feed Irons. In this type, water is contained in an unheated tank from which it is allowed to drip through a needle valve into an enclosed space in the soleplate. Here it vaporizes on contact with the hot iron and the resulting steam is led through a series of holes to the ironing surface. The needle valve is opened and closed by operating a button in the handle of the iron, and in the "steam position" allows water to pass at a pre-determined rate. The sole plate is of aluminium alloy and is heated by an element which is embedded in the sole plate. The soleplate temperature is thermostatically controlled and is set by means of a large knob on top of the cowl, the appropriate position for steam ironing being clearly marked. It should be noted that the drip-feed type will only operate satisfactorily at one fixed temperature; this is the type which will produce **instant** steam, or **instant** dry ironing, by the turn of the knob.

Kettle Type Irons. The water tank in this type is directly heated by the soleplate. A form of "steam dome" is fitted to the top of the tank from which the steam pipe to the aperture in the soleplate is supplied. This soleplate is also of aluminium alloy, heated by an imbedded element, and thermostatically controlled. The method of filling varies with the make of iron, but in all cases the filler hole is closed before ironing. With kettle type irons the ironing temperature may be varied according to the fabric being ironed, and these are marked on the control dial.

The Kenwood light-weight electric Steam-O-Matic. This is a kettle type of iron, with automatic control of both heat and steam throughout a full range of temperatures by dial control.

Users should be reminded that for safety these irons should be disconnected from the electrical outlet before filling.

Neither type of iron should be over-filled. Vigorous use of the drip-feed type will cause excess water to be ejected from the opening in the handle and too much water in the ketle type leads to the excess being carried over by the steam. A measure is provided with one iron to assist the housewife in this respect.

An important point in hard water areas is the possibility of furring up in the water container and also the steam outlets if distilled water is not used. The growth of scale cuts down the volume of steam generated.

The use of soft, preferably distilled, water, is generally recommended, although the occasional use of tap water if the user has run out of distilled water will have little effect on the iron.

Since the advent of steam irons in the U.S. for example, the consumer has been advised to use commercially distilled water, rain water, or the defrostings from her refrigerator—all three of which are mineral free.

This advice is given as a protection to the customer, for while mineral deposit can be cleaned from the iron by the housewife, it can be particularly annoying for customers who live in a hard water area when the mineral deposit builds up quickly within the iron.

DEMONSTRATING STEAM IRONS

Steam is a handy way of spreading or putting moisture into a garment. Water plus **heat** removes wrinkles. Steam itself will not remove wrinkles. It is only when steam is condensed on a cold cloth, and is immediately followed by a heated iron, that wrinkles are removed by steam ironing. The cloth must still be cold enough to condense the steam into moisture, otherwise the steam will prove ineffective, and a poor ironing result will be obtained.

Since it is water and not steam which is required in a cloth, the lowest degree in steaming that can be used without spotting the cloth is the most desirable.

Points to remember in demonstrating:

Fill the iron according to instructions and do not overfill. The use of hot water will speed the heating process in kettle type irons. Emphasize the use of mineral-free water to the customer. If it is necessary to refill a hot iron the same procedure should be followed: a small puff of steam is to be expected as the first few drops of water enter the tank, but if reasonable care is taken this is quite harmless and it quickly ceases.

Set the thermostat (a kettle type iron) to the highest setting and put aside to heat. An iron of the kettle type should be placed on an iron stand and not on the heel, as the tank is designed to accommodate the water in an unheated position when the iron is thus out of use. If the closing valve of a kettle type iron is left raised, steam will be seen issuing from the filler when the iron is ready for use. The valve should at this time be closed, and if not required immediately, the iron placed on its heel. A steaming iron must not be left resting horizontally on a soft asbestos stand as this causes asbestos to adhere to the soleplate.

Show the steam issuing from the soleplate as part of your demonstration. To do this, raise the iron to eye-level with the soleplate horizontal, when the steam will be seen as a "blanket" under, but not apparently touching, the soleplate. The reason for the apparent separation is that the steam close to the soleplate is superheated and therefore invisible. The iron must not be turned upside down: if this is done water enters the steam dome of a kettle type iron and is ejected; in the case of a drip-feed type the water runs out of the filler hole.

Use flannelette, or a grey flannel shirt for demonstrating, as either will take a most impressive pleat or crease in a single stroke of the iron. Let the customer handle the iron herself—she is sure to be particularly impressed by the light weight. Steam ironing is suitable for any type of laundry which would normally be dampened. Starched garments may require slightly damping first. When used for pressing, it is not necessary to use a dry cloth over the garment unless it is a serge or gaberdine, both of which are very susceptible to shine. Obstinate creases in difficult material may be removed by slowly passing the iron over, but not touching, the cold material before pressing. This allows steam to condense within the material, restoring that condition which gives the best results.

Emphasize that steam irons are perfectly safe. The element is embedded in cement and the water in the container simply cannot get in contact with the element.. Tell your customer that when she buys a steam iron she is getting all her ironing done in the most trouble free manner. She is saving on damping down time for all her damped ironing; she has a wonderful appliance for pressing; and by pressing a button on the drip type iron or emptying the water from a kettle type iron she has a first-class dry iron for her other purposes. And all this in a **lightweight** product—so that she irons with the minimum of fatigue.

WHAT IS A DABBLER?

(Reprinted from "Wireless and Electrical Trader")

So great has been the recent concern about the dabbler menace that I think some effort should be made to get the whole question into perspective. We, in service, are most directly concerned, since we suffer most from their depredations. First of all, how do we classify a dabbler?

In the first place, I have never agreed with the definition of a radio engineer or trader as laid down by the trade organizations. We must take **service** our yardstick in judging this complex problem. The man who works at another job all day, and spends his leisure time trying to make pocket money, is one example of the true dabbler. Every effort should be made to stop this sort of thing, but the fact that some dealers will not supply components is no answer. Capacitors, resistors, and other service materials have a retail price, and are offered for sale at this price. If the dealer will not supply, he is definitely out of order, and in any case, the dabbler can obtain supplies even direct from the maker, who is bound to supply him at retail prices so long as he produces the money. He can afford to pay retail prices too, as his ultimate charge to his victims takes good care of that.

What can be done about this particular gentleman, then? Candidly, very little. The most we can do is to let him eventually put himself out of business, and he usually does by shoddy workmanship. In the meantime, why miss the profit on the components he buys?

The other form of dabbling, or unfair trading, if you prefer it, is much more serious and hurts the purse of the genuine dealer very much more. I refer, of course, to the person, or firm, who is not really engaged in the radio trade and does not intend to maintain a service department or give any after-sales service whatsoever. Not quite so simple are the firms who come in between—the man who is engaged in another trade but sells radio on the side. And do not forget that this, if taken to its logical conclusion, could even include electrical engineers and gramophone dealers. Why should an electrician or a retailer of gramophone records be any more entitiled to sell radio than a retailer of toys or cycles or stationery, if he does not intend to give adequate service after sales? Conversely, why should the radio dealer sell refrigerators, washers and other electrical units unless he is prepared to give proper service? Let us again apply that all-important word **service**.

In addition to all these aspects of the "dabbler" menace, we should also realize that the "country" dealer has a very different set of circumstances with which to deal than his contemporary in the city. In some sparsely inhabited regions it would be almost impossible for any dealer to live out of radio alone. His business, of necessity, must be of a mixed nature, but, provided that he in his turn is prepared to give the all-important service after sales, he cannot be classed as a dabbler.

Finally, in this trade of ours which has many restrictive trading practices, it behoves us to keep some sense of proportion and not to make the legitimate entry into our trade subject to any conditions save those of ability and honest intentions. Any other course is both unfair and predestined to failure.

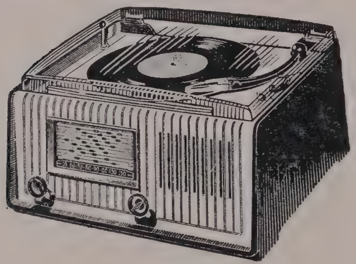
NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars contact Advertising Manager, R. & E., Box 8022, Wellington.

Philips—world leaders in radio engineering—introduce the latest electronic marvel, "Ferrocoustics," for superlative listening pleasure.

In these three new Philips models, Philips provide beauty and design and superior workmanship, while Philips Ferrocoustics promise you exceptional reproduction from both radio and record player units. The built-in Ferroceptor rod aerial provides excellent indoor reception without external aerial. Distributed by Philips Electrical Industries of New Zealand Ltd., Auckland, Wellington, Christchurch, and Dunedin.

PHILIPS RADIOGRAM MODEL 756—"VISTAGRAM"



With its modern plastic top and featherweight pick-up with dual sapphire stylus, the Model 756 is one of the most compact table radiograms ever produced. It features a new three-speed record player (Type AG 2002), flush mounted with microphonic free spring suspension.

Amongst the general highlights of this five-valve superheterodyne receiver is the new high sensitivity "Ticonal" magnet loudspeaker. The Micro "12" I.F. transformers with Ferroxcube core give high sensitivity and good selectivity. There are external aerial and earth connections. The attractive modern moulded cabinet in maroon and baked cream enamel has a Methacralyte clear injection moulded lid. The glass dial is of the slide-rule type, and the dimensions of the whole cabinet are: Length, 15 in.; height, 8 in.; and width, 14 in.

Price, £39 10s.

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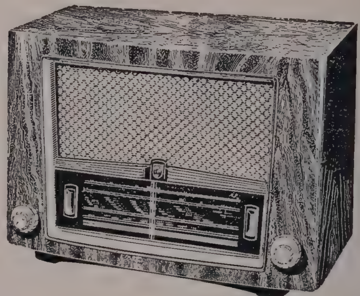
PHILIPS RADIOPLAYER MODEL 456

Philips exclusive Ferroxcube micro-magnetic components bring new high fidelity to this superlative instrument, the brilliant new Radioplayer, Model 456. New "Micro-12" band pass filter, Ferroxcube coils, the astonishingly efficient Ferrocepter built-in rod aerial, and other Ferroxcube components put Model 456 in a class by itself for both all-wave radio reception and for record reproduction.

Specifications: Philips precision anti-microphonic condenser gang with non-slip drive and Philips air-dielectric trimmers ensure long-term dead-accurate tuning; Philips Rimlock valves; tuning bands; broad-



cast, 535 to 1740 kc/s.; shortwave, 5.5 to 19 mc/s.; bandspread on 25 and 31-metre bands; dial, plate-glass, edge-lit; continuously variable tone control; high-quality "Ticonal" speaker; terminals for quick, simple attachment of extension speaker and gram pick-up leads. Dimensions: length 19 in., height 12¾ in., depth 8 in.

Price, £38 17s. 6d.

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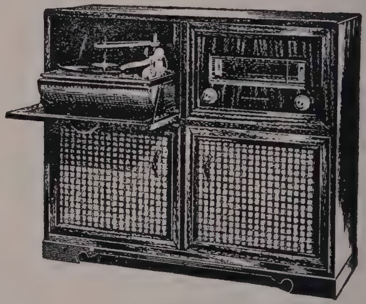
PHILIPS RADIOGRAM MODEL 956



Special features of this Philips radiogram, with its gloriously polished cabinet of beautifully grained, solid mahogany, are the new smooth-action record changer mounting which pulls out clear of the cabinet, the Philips three-speed automatic record changer, type AG 1000, and crystal pick-up, type AG 3010, with dual sapphire stylus. There is a special high-sensitivity "Ticonal" magnet 10 in. speaker, and a new circuit using special tone control with incorporated bass switch. The radio has a clear glass dial scale with clearly marked stations, and dual concentric push-on tuning knobs. In addition, two roomy compartments in the cabinet provide ample storage space for records. Overall size of radiogram is 37¼ in. long, 32⅛ in. high, and 15½ in. wide.

Hear the difference that Philips Ferrocoustics make to the reproduction of your favourite recordings. Turn on the radio! Discover stations you've never heard

before, while local stations come in with all the strength you'll ever need.

There is a built-in adjustable Ferroceptor rod aerial. Wave ranges: Broadcast, 535 to 1735 kc/s.; shortwave, 5.5 to 19.5 mc/s.; bandspread, 25 and 31 metres.

Price, £110.

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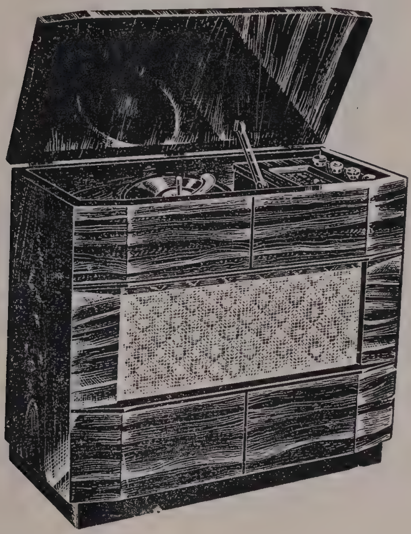
PYE NEWS

Pye please again with two new and attractive console radiograms in different price brackets. Model 56RG retails at £69 10s. and the new 79RG retails at £97 10s.

Pye Model 79 RG



This model is right up in the top class for performance and eye-appeal, and £97 10s. is not a high price to pay for a model of this quality.

The 79 RG is a six-valve, eight-wave bandspread model equipped with the reliable three-speed Garrard automatic record changer, and is housed in a cabinet of highly polished walnut.

To make for easier tuning, the 79 RG has a magic-eye, and the eight-wave bandspreading covers the 11, 13, 16, 19, 25, and 31-metre bands, the shortwave band (3.4 to 8 megacycles), and the broadcast band (550 to 1600 kc/s.).

An unusually high standard of reproduction is obtained by a 12 in. loudspeaker capable of wide frequency range. A wide range of tonal reproduction is achieved by the use of tone variations covering "Fidelity," "Brilliant," "Mellow," " and "Speech."

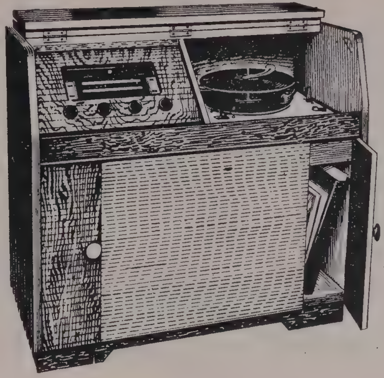
A further refinement incorporated in this model is special frequency compensation for faithful reproduction of both standard and long-playing recordings.

The walnut cabinet in contemporary design measures 35 in. wide x 30½ in. high x 17 in. deep.

Pye Model 79 RG, retail price, £97 10s.

Pye radios and radiograms are distributed throughout New Zealand by Pye (New Zealand) Ltd., P.O. Box 2839, Auckland.

Pye Model 56 RG



This is a five-valve broadcast console radiogram finished in attractively grained oak. The player unit is a Garrard three-speed auto-change model.

The outstanding feature of this model is the "pick-up compensation" switch, designed to provide true reproduction of both long-playing records and 78 r.p.m.

The oak cabinet of model 56 RG gives easy access to tuning controls and the player unit, and convenient record space is provided. It is both elegant and compact; dimensions are: 33½ in. wide x 16 in. deep x 30½ in. high.

Retail price, £69 10s.

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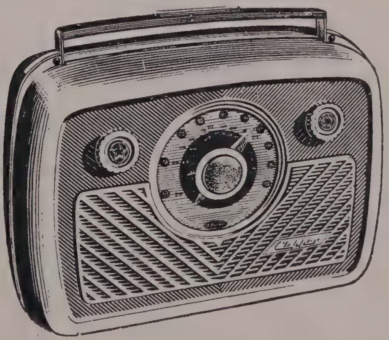
THE NEWEST CLIPPERS

G. A. Wooller & Co. Ltd. introduce two new models to the already extensive Clipper range—Model 6P6, an A.C./D.C. and battery portable, and Model 966, a six-valve console radiogram.

These sets fill a much-needed want in public demand, and dealers will find a ready acceptance of their distinctive features.

Clipper Model 6P6



This new Clipper model is a six-valve A.C./D.C. and battery portable weighing 12½ lb. (ready for use). Five actual valves are used—the converter is the rimlock type, while the remainder are miniature battery series valves—and the H.T. voltage is produced by a selenium rectifier. With this set-up, model 6P6 gives very satisfactory six-valve performance on both mains and batteries.

One of the main points of interest, to both radiotricians and the fan, is that Model 6P6 incorporates battery re-activation. Batteries can virtually be recharged while still in position by plugging the radio into mains and switching to "Re-activate." A "re-activate" position is incorporated in the on/off switch, and by operating the set in this way the life of both H.T. and L.T. batteries is greatly increased.

The cabinet of the Clipper 6P6 is of high-impact polystyrene, and it is available in three colour schemes —Ivory, Grey and Ivory, and Burgundy and Ivory. A retractable carrying handle makes the 6P6 very neat and tidy when used in the home as a mantel model, and easy opening of the cabinet greatly simplifies battery changing. The heavy-duty batteries all plug in, and the plugs are arranged so that batteries cannot be wrongly connected.

The whole weight of the receiver is carried by the chassis, so that jolting when carried will not damage the cabinet.

Model 6P6 covers the broadcast band (1600 to 550 kc/s.). Dimensions overall are 14 in. long x 10 in. high x 5⅛ in.

All in all, Model 6P6 has been designed around the latest technical developments in radio components, circuitry, plastic moulding, and mechanical engineering techniques, which, together with modern styling, make this set one of the leading portables on the market today.

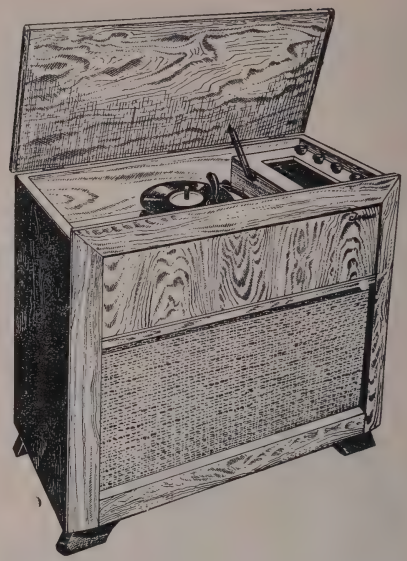
Retail price, £32 10s.

CLIPPER MODEL 966

Model 966 is a radiogram of quite outstanding good looks and performance that is remarkable for a console model retailing at £68 19s. 6d.

Model 966 has a six-valve receiver covering the broadcast band, a three-speed auto-change player unit, and 12 in. loudspeaker. (Sockets are provided for an extension speaker also.)

One unusual feature of this model is the special radio-gramophone switch. This is a three-position



switch covering radio, 78 r.p.m., and long playing. The two positions, 78 r.p.m. and L.P., are so arranged that the correct pick-up compensation is applied for true reproduction from both 78 r.p.m. and long-play discs.

The oak cabinet of the Clipper 966 has been carefully designed for easy operation, and provides ample record storage in a handy position. Dimensions are 34 in. wide x 16½ in. deep x 34 in. high.

Model 966 can be recommended to be "at home" in any home—and the price is only £68 19s. 6d.

G. A. Wooller & Co. Ltd., sole New Zealand distributors of Clipper radios, invite inquiries from the trade, at their head office, Box 2167, Auckland, or at 43 Lower Taranaki Street, Wellington, and 16-18 Victoria Street, Christchurch.

The Nuclear Power Plant Co. Ltd.

A group of firms who either have had close association with the United Kingdom Atomic Energy Authority in the design and construction of the Calder Hall Atomic Power Station, or in experimental reactors for Harwell, or who have special experience and facilities for such work, are associated with a recently incorporated separate company which will concentrate on the research, design, and construction of nuclear power stations.

Registered with an authorized capital of £1,000,000, the Nuclear Power Plant Co. Ltd. has its registered office at Heaton Works, Newcastle upon Tyne. The design headquarters is Booths Hall, Knutsford, Cheshire.

The associated companies are: C. A. Parsons & Co. Ltd., Newcastle upon Tyne; A. Reyrolle & Co. Ltd., Hebburn-on-Tyne; Head, Wrightson & Co. Ltd., Thornaby-on-Tees; Sir Robert McAlpine & Sons Ltd., London; Whessoe Limited, Darlington; Strachan & Henshaw, Bristol; Alex. Findlay & Co. Ltd., Motherwell; Clarke, Chapman & Co. Ltd., Gateshead-on-Tyne.

Parsons, Reyrolle, Whessoe, Strachan & Henshaw, and Alex. Findlay have gained valuable experience in the development of the Calder Hall Power Station. Head, Wrightson have had wide experience in the design and manufacture of modern heat exchange equipment; they have been engaged for some time in the design and construction of various types of reactors at Home and abroad; they are also designing and building the large heavy-water plant in New Zealand. Clarke, Chapman have wide experience in steam-raising and allied equipment. McAlpines have been outstandingly successful in the civil engineering field, particularly in the construction of power stations for the Central Electricity Authority.

The combination of these eight firms will enable the Nuclear Power Plant Co. Ltd. to design and construct atomic power stations in any part of the world.

The Parolle Electrical Plant Co. Ltd. (joint proprietors, Parsons Reyrolle), who have been associated with the Atomic Energy Authority in the design and construction of the Calder Hall Power Project, will co-ordinate the activities of the eight operating companies in design and construction. They also will be responsible for site services.

TRADE WINDS

ELEKON (OVERSEAS) LTD. APPOINTED DISTRIBUTORS FOR HEATHKITS

Elekon (Overseas) Ltd., a division of Electronic Controls and Appliances Ltd., of Auckland, announce their appointment as distributors of Heath Kitsets.

In the United States this equipment is widely used, as it permits many a closely pruned budget to be stretched to include measuring equipment ordinarily considered a laboratory luxury. News of the availability of this equipment in New Zealand will be welcomed by servicemen and constructors.

* * *

DECCA TO FESTIVAL

As published in "Radio and Electrical Review" last month, Festival Records Pty. Ltd., Sydney, announce that they have acquired the entire rights to the manufacture and sale in Australia and New Zealand of the famous Decca Inc., U.S.A., label, as from 1st January, 1956.

The acquisition of the Decca Inc. U.S.A. catalogue, in its entirety, will make Festival one of the largest record manufacturing and distributing companies in Australia and New Zealand, and will bring to buyers of Festival records such world-famous artists as Bill Haley, Sammy Davis Jun., the Four Aces, Louis Armstrong, Bing Crosby, Danny Kaye, Ella Fitzgerald, Ink Spots, Carmen Cavallaro, Mills Brothers, and hundreds of others that assure Festival of the top versions of "hit parade" numbers, also a wide range of classical, semi-classical, and musical comedy music.

The world-famous labels, Westminster of U.S.A., Vox of London, Bell of U.S.A., and Metronome of Sweden, will continue to be pressed and distributed as before. Sole New Zealand distributors for all Festival labels are G. A. Wooller & Co. Ltd., Auckland.

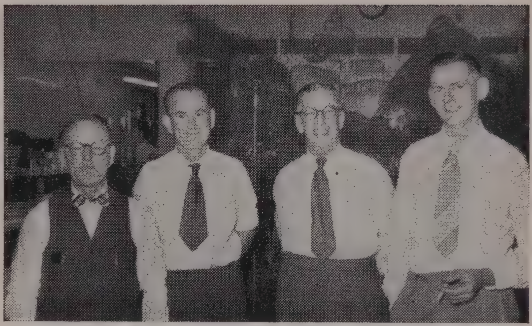
* * *

HAPPY SCENES FROM ULTIMATE-EKCO CANDLELIGHT SOCIAL

Pictured above are two happy glimpses of patrons at the Ultimate-Ekco (N.Z.) Ltd. 15-Year Club Candlelight Social reported in our January number.

Immediately above: From left to right, Messrs. L. Teat, A. Watkins, R. J. Orbell, W. Murphy and R. Orange.

Right-hand column, left to right: Messrs. M. Hamilton, W. Curtis, D. T. Clifton-Lewis, and C. Lovell.



BRITISH TV "WORTH IMITATING" "INFINITELY SUPERIOR PICTURE," SAYS AMERICAN EXPERT

Mr. Jack Gould, television critic of the "New York Times," and probably the best-known radio writer in the United States, in a dispatch from London, says there are some lessons for American TV to learn from the British. He refers in glowing terms to the B.B.C. Eurovision and other programmes and chides his countrymen for not capturing some of the "superbly interesting material" on film.

On picture quality, Mr. Gould writes:

"Finally, there is a technical lesson to be learned from British television, one that has a special and fresh pertinency with this fall's many colour 'spectaculars' in the United States. The quality of the British image is infinitely superior to the American picture. This was noticeable here two years ago, but it is apparent that American TV hasn't improved in the interval.

"Theoretically, our picture should be the better. The American standard calls for a picture of 525 lines, whereas the British image is 405 lines. According to a New York TV engineer who has been helping the British commercial station get on the air, the answer lies not in the sets but in the British camera pick-up equipment. He explained that the British equipment was less operational than the American but more meticulously constructed and operated.

"Whatever the reason, the American stations should stop taking engineering shortcuts and see what they can do. From the viewer's standpoint, it would be worth every penny. And if greater engineering care in the studios and at the transmitters would help eliminate some of the fuzziness on black-and-white receivers during colour transmissions, it certainly should be done. The clean British picture, even on larger sets, is certainly a pleasure to watch."

"R & E" TECHNICAL PHOTOGRAPHS

Copies of original designs produced in our laboratory and featured in these pages are available. Prices are: Size 6 in. x 4 in. 3s. 6d.; 8 x 6, 4s. 6d.; 10 x 8, 5s. 6d. Please remit cash with order to Radio and Electronics (N.Z.) Ltd., P.O. Box 8022, Wellington.

TAPE-RECORDING GLOSSARY

We are indebted to our American contemporary journal, "Radio-Electronics", for the following Tape Recording Glossary, which appeared in the July, 1955, number, and which we reproduce for the benefit of New Zealand tape recorder enthusiasts who may not have access to this excellent journal.

The subject of tape recording has become very popular in recent years and like high fidelity, it has produced a jargon all of its own. Because of the somewhat parallel growth and relationship of hi-fi and tape recording, many technical terms are common to both. The following is a list of terms specifically associated with the field of tape recording, prepared by the Minnesota Mining and Manufacturing Co., makers of "Scotch" brand tapes.

Acetate Film:
The super-smooth, transparent plastic film which forms the tough backing for approximately 90 per cent. of magnetic recording tape made in the world today.

A Wind (rhymes with kind)
Magnetic tape wound on the reel with the dull, oxide-coated side of the tape toward the inside. This wind is almost universally used today. Recorder design determines whether A or B wind tape is required.

B Wind
Tape wound with oxide out. It is seldom used today. Wind can be changed from A to B by putting a half twist in the tape and rewinding on the recorder.

Bias
A high-frequency alternating current fed into the recording circuit to eliminate inate distortion.

Bulk Eraser
A 117-volt A.C. device used to erase an entire reel of magnetic tape at once without running it through a recorder. A strong magnetic field neutralizes the magnetic patterns on the tape.

Capstan
The spindle or shaft—often the motor shaft itself—which rotates against the tape, pulling it along at a constant speed on recording and playback.

Dual-track Recorder
Usually a tape recorder with a recording head that covers half of the tape width, making it possible to record one track on the tape, then turn the reels over and record a second track in the opposite direction. Sometimes called a **half-track recorder.**

Dupe
Sometimes called a **dub** or **dubbing.** A copy of a tape recording made by recording on one machine what another machine is playing. Tape recordings are easy to duplicate by re-recording and there is a minimum loss in quality from the original to the copy.

Dynamic Range
The ratio between the softest and loudest sounds a tape recorder or other device can reproduce without undesirable distortion. Usually measured in db.

Editing
Selecting certain sections of a tape recording or of a number of different tape recordings, then splicing them together in the desired sequence. Magnetic tape is unsurpassed for editing purposes since it can be easily cut and spliced.

Gap
The tiny distance between the poles of the recording head, measured in mils. The head gap of home recorders may range from 1 mil (0.001 inch) down to ¼ mil. The smaller the gap, the higher the frequency range of the tape recorder can be.

Head
The ring-shaped electromagnet across which the tape is drawn and which magnetizes the iron-oxide-coated tape in a series of patterns. Most tape recorders use a combination record-playback head and also an erase head. Some professional machines also have a monitor head for listening to the recorded sound a split second after it has been put on the tape.

Index Counter
An odometer type counter which makes it possible to note the location of any particular selection of a tape, thereby making it easier to find. Many late model tape recorders feature built-in index counters.

Leader and Timing Tape
Special, tough, non-magnetic tape which can be spliced to either end of a tape to prevent damage or breaking off of the magnetic tape ends and possible loss of part of the recorded material. White in colour, it features a 1-inch plaid marked every 15 inches. Used as a timing tape, therefore, it can be spliced between musical selections on a tape, providing a pause of a given number of seconds, depending on the tape speed.

Level Indicator
A device on the tape recorder to indicate the level at which the recording is being made, and which serves as a warning against under-recording or over-recording. It may be a neon bulb, a "magic eye" or a VU meter.

Magnetic Tape
A high-quality plastic or paper tape which has been precision-coated by the manufacturer with a layer of magnetizable, iron-oxide particles. The result is a recording media that is subject to virtually no wear, can be erased and re-used and offers the highest fidelity of reproduction possible today.

Motor Board
Also called **Tape Transport Mechanism.** The platform or assembly of a tape recorder on which the motor (or motors), the reels, the heads and the controls are mounted. It includes those parts of the recorder other than the amplifier, pre-amplifier, loud-speaker and case.

Oxide
Microscopically small particles of ferric oxide dispersed in a liquid binder and coated on a tape backing. Red oxide is most common; some magnetic tapes use a dark green oxide. These oxides are magnetically "hard"—that is, once magnetized, they remain magnetized permanently, unless they are demagnetized by exposure to a strong magnetic field.

Polyester Film
Plastic film backing for magnetic tape used for special purposes where strength and resistance to humidity change are important.

Pressure Pads
Felt pads mounted on spring-brass arms which hold the magnetic tape in close contact with the heads on some machines.

Pressure Roller
Also called capstan idler or puck. A rubber-tyred roller which holds the magnetic tape tight against the capstan by spring pressure to insure constant tape speed and prevent slippage.

Raw Tape
A term sometimes used to describe tape that has not been recorded. Also called **virgin** tape.

Self-powered Recorder
Tape recorder containing its own power supply, either a combination of wet and dry cells to power the unit or dry cells in conjunction with a spring-driven motor.

Single-track Recorder
A tape recorder which records only one track on the tape. Usually a full-track recording head is used which covers the full width of the ¼ in. tape although some machines use a narrower, half-track recording head which records a single track down the middle of the tape. Output of a full-track recording is theoretically double that of a half-track recording, although actually it is only slightly greater because of improved half-track head design.

Splicing Tape
A special, pressure-sensitive, non-magnetic tape used for splicing magnetic tape. Its "hard" adhesive will not ooze and consequently will not gum up the recording head or cause adjacent layers of tape on the reel to stick together. Cellophane tape should never be used.

Tape Guides
Grooved pins of non-magnetic material mounted at either side of the recording head assembly to position the magnetic tape on the head as it is being recorded or played.

Tape Loop
A length of magnetic tape with the ends joined together to form an endless loop. Used either on a standard recorder, special "message-repeater" type units or in conjunction with a cartridge device, it makes it possible to play back a recorded message repetitively without rewinding the tape.

Tape Speed
Speed at which tape moves past the recording head. Standard tape speeds for home use are 3¾ and 7½ inches per second (i.p.s.). Faster speeds sometimes used are 1⅞ and 15/16 i.p.s. Faster speed makes possible improved high-frequency response, while slower speed means greater tape economy. If a tape is recorded at 3¾ i.p.s., then played back at 7½ i.p.s., all sounds will be raised 1 octave in pitch Cutting the speed in half lowers a tone 1 octave.

Threading Slot
Slot in recording head assembly cover plate into which tape is slipped in threading up the reels for use of the recorder.

VTR
Video tape recording. Recording and reproducing television picture-tube signals on standard—but highest quality—magnetic tape. It is extremely difficult to design a tape recorder capable of handling a wide frequency range up to 4 mc. Usually several magnetic tracks are recorded side by side on a ½-inch tape at a considerably higher speed than used in home recording, each track recording a certain range of frequencies. Improved quality and lower operating cost are expected to enable it to replace movie film for TV use.

NEW BRITISH TV EQUIPMENT

EXTENDING RANGE OF OUTSIDE BROADCASTS

B.B.C. television outside broadcasting equipments recently brought into use include several which are in advance of practice in other countries. All are British made.

B.B.C. vehicle on site with mast extended and radio link transmitter equipment mounted at top. This vehicle has been designed for use with centimetric link equipment allowing the paraboloids to be extended approximately 60 ft. from ground and operated by remote control.

—Photograph by courtesy of the B.B.C.

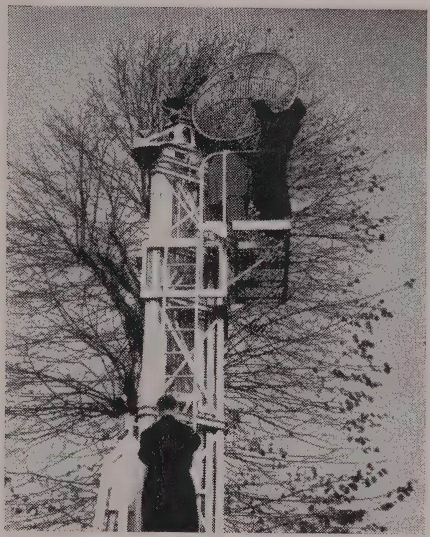
The smallest is the miniature radio transmitter carried by a commentator when a boom microphone is not available and a baton one, with its trailing cable, is an encumbrance. The transmitter, designed by the B.B.C., is about the size of a packet of 20 cigarettes and the battery is only slightly larger. The microphone, a standard production of British industry, about an inch in diameter, can be worn on the lapel. The aerial consists of a piece of wire usually worn down the trouser-leg. With an output power of approximately 0.25 watts, it is believed to be the smallest high-grade transmitter of its power available. It was recently used by the Archbishop of Canterbury in a B.B.C. interview with Richard Dimbleby.

New microwave link equipment allotted to each of the B.B.C.'s regions has enabled outside broadcasts to be taken from places distant from the national television network, as, for instance, from Dublin, when four microwave links were used in tandem.

A new extending-tower vehicle enables the radio link transmitter or receiving aerials to be raised to 60 ft. above the ground. A 4 ft. paraboloid aerial can be rotated throughout 360 degrees horizontally and can be aligned on the distant aerial with an error of less than half a degree.

This equipment is enabling outside broadcasts to be undertaken from sites where in previous circumstances transmission or reception would have needed the erection of elaborate scaffolding.

The B.B.C. "Roving Eye," which first consisted of a single camera with control equipment, microphone sound equipment, and VHF transmitters for sending vision and sound signals to a fixed receiving point,



Mounting of the radio link paraboloid on top of the mast.

—Photograph by courtesy of the B.B.C.

has now been improved upon. The second "Roving Eye" vehicle has two camera channels, one fitted with a zoom lens.

There are also four new mobile control rooms in self-propelled vehicles to replace two earlier trailer types. Each vehicle is equipped with three image orthicon cameras with their associated control units and all equipment for putting on a complete outside broadcast programme. A new feature is that lenses of two-inch and forty-inch focal length can be mounted simultaneously. A new variable density light filter enables scenes with widely different degrees of brightness to be televized successfully. The sound equipment can deal with up to 10 microphones.

A new zoom lens of British design and make has recently been acquired. It has two ranges, one giving a variation in focal length from 4 to 20 inches and the other from 8 to 40 inches.

For television outside broadcasts which are being carried on the European ("Eurovision") network in addition to being radiated by the B.B.C.'s own stations, a vehicle has been designed to handle fifteen separate commentaries in different languages, with a further four microphones for background effects, such as crowd noises and cheers.

BACK NUMBERS OF "R. & E."
Available from our Office,

For the Technician

Morphy-Richards Auto-Control Safety Electric Irons

GUARANTEE

In the event of any defect being disclosed in any part manufactured or supplied by the manufacturer, the manufacturer will undertake, at his option, free of cost, to repair or replace such defective part subject to the following conditions:—

(1) The defective part must be observed within the guarantee period and be available for return to the manufacturer upon demand.

(2) The defect must be found, when examined by the manufacturer to be due exclusively to faulty material and/or workmanship, and not to wear and tear, dirt, misuse, neglect, accident, or other similar causes.

(3) The manufacturer is not to be liable for labour or for any loss or expense arising from the breakdown of any parts or for any consequential damages, direct or indirect, or for any repairs made or attempted to be made without the written sanction of the manufacturer.

(4) The guarantee seal must be returned with any claim under the guarantee to establish the date of purchase, and the guarantee becomes null and void if the iron is altered or interfered with in any way by any person not in the manufacturer's employ or acting on the manufacturer's instructions.

Brief Description of the Morphy-Richards Auto-control Iron

Mains are connected to the element via a switch operated by a bi-metal strip fitted into the sole-plate. The switch contacts are on two spring leaves. The lower works against a cam operated by the manual control. As the plate temperature increases, the bimetal strip and rod rise, allowing the spring leaves, which have an upward bias, to rise also. The lower leaf is arrested by the cam, thus opening the switch. Manual control, by means of control knob on body, by fixing amount of rise before current is interrupted, determines the temperature.

A pre-set adjustment consists of a porcelain bush and adjusting nut fitted to the top leaf and working on the screwed end of the rod coupling to the bimetal strip.

In series with the circuit is a pilot lamp; this has a parallel resistance, the voltage across it being 1½ volts.

Fault Finding

Faults usually may be divided into one of three categories:

(1) Mechanical damage.

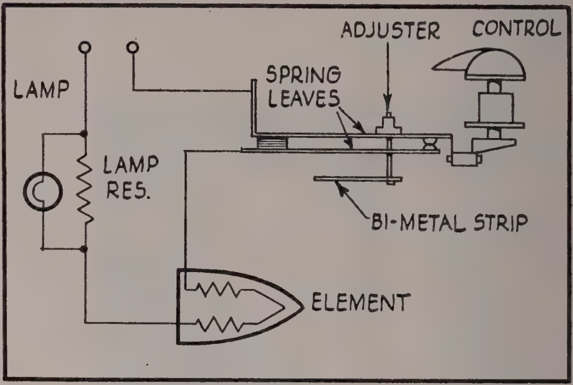
(2) Electrical failure.

(3) Displacement of temperature control.

Mechanical damage is usually obvious, and may not necessitate the complete dismantling of the iron, but the electrical condition and temperature setting should always be checked.

Sole Plates

Sole plates which are damaged, rusty, peeling, or which have deteriorated through use, should, whenever desirable, be changed with the consent of the customer. Only a sole plate in first-class condition can give satisfaction to the user.



THE ELECTRICAL CIRCUIT

SECTION 2

Preliminary Tests

Generally inspect for mechanical damage and list faults.

Examine sole plate for damage and wear. Check plug for correct wiring.

Examine flex and replace if necessary.

Replace any broken parts; for method, refer to appropriate section.

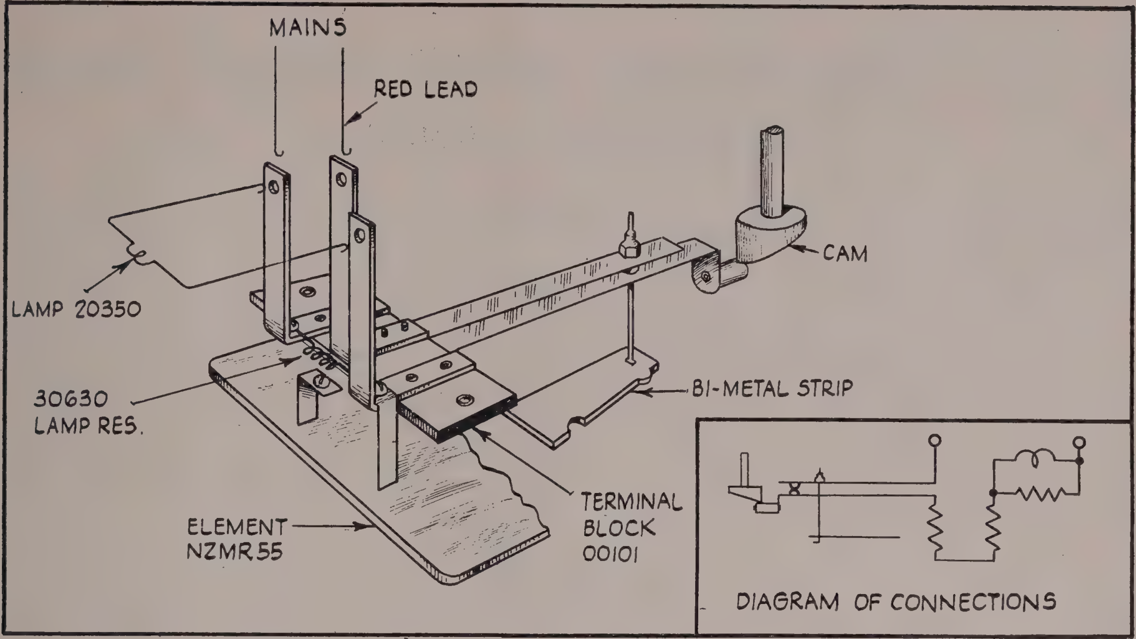
Carry out the following insulation tests:—

(1) Test insulation on megger, between both mains leads and earth wire. All tests should show 2 megohms at least. A lower reading may be obtained if the iron has not been used immediately prior to test, owing to damp in the asbestos liner. This is harmless, and will disappear on warming up. There will be no difficulty in detecting an actual insulation breakdown, but, before deciding, heat iron and recheck insulation.

(2) Test for continuity through the mains leads. The indicator should show circuit in all knob positions unless the iron is hot. Note that the bulb lights when mains voltage is applied to the leads.

The foregoing tests should be made in any case. Only if they show no fault, proceed to temperature settings.

(3) Check the temperature range by setting the control knob to the "Wool" position—that is, with the tail of the control knob pointing to the rear of the iron. Place iron on pyrometer, connect the mains. The thermostat should cut out between 165° and 185° C., and in again between 155° and 175° C. If it does, setting is correct; if not, reset as explained in Section 10.



SECTION 3

Dismantling Handle and Body

(1) First remove the lamp cover 30607 which is held by the single recessed screw at the rear of handle.

If the fault is an insulation one, it is desirable to recheck in case it is due to the lamp contacts fouling any of the connections in the handle. If the lamp has not been lighting, it may now be checked by putting approximately 2v. from a battery across its contact strips. If lamp is unserviceable, replace. If lamp cover is unserviceable, replace.

(2) Remove the control knob 30609 by loosening the grub screw under its tail; replace if broken or burnt. If the fault is in the temperature range, note if the grub screw has been seating on the "flat" on the spindle intended for it.

(3) To remove body:

(a) Remove centre screw at rear, which also clamps the earth lead.

(b) Disconnect the mains leads from their brackets.

(c) Unscrew the front brass nut 30611, using the box spanner provided. The body can now be lifted from the sole plate assembly.

(4) If the insulation has proved defective, the flex can now be rechecked with insulation tester.

(5) Should any breakages have occurred, replacement of body and handle can now be made, noting the position of asbestos washers between body and handle.

(6) Replace flex if necessary.

SECTION 4

Insulation Tests

A fault indicated in one or more of the tests already described may now be located on the chassis. The following tests are, therefore, alternatives, but it is particularly important to determine if there is more than one fault. For instance, a breakdown of the element insulation may be followed by burning out of the element or lamp resistance, giving "open circuit" as well.

(1) Inspect contacts for obvious earth.

(2) The element insulation can now be tested.

(3) A break in the circuit can now be located by checking.

(4) From left-hand bracket to right-hand bracket (indicates break in lamp resistance 30630); if faulty, replace.

(5) From right-hand bracket to lower centre bracket (indicates break in element, N.Z. MR55); if faulty, replace.

(6) Remove elements screws and disconnect element.

(7) Test insulation from centre bracket to earth. This will check the insulation of the eyelet on old-type T.B.A. on the upper spring leaf. If this is faulty, replace the terminal block assembly (35501).

(8) From lower centre to upper centre brackets (indicates that contacts are open). To recheck this, replace the control knob and move over the normal range.

(To be continued.)

CLASSIFIED ADVERTISEMENTS

Rates 4d. per word, minimum charge 3s. Deadline date 1st of month preceding publication.

BINDERS FOR "R. & E."

These are available to hold 12 issues—price 6s. 6d.

For the Serviceman

PHILIPS RADIOPLAYERS BZ 356 A AND BZ 357 A 5-VALVE SUPERHETERODYNE RECEIVER

The cabinets of Models BZ 356A and BZ 357A are identical, the difference between the two models being the inclusion of the shortwave band, 5.5-19 mc/s., on BZ 357A. These service remarks apply equally to both models unless specially stated.

REMOVAL FROM THE CABINET

Most service work on these models, including alignment and the replacement of volume and tone controls, may be carried out while the chassis is still mounted in the cabinet. Whenever it is essential to remove the chassis from the cabinet, proceed as follows:—

Remove the mains plug from the supply.

Remove the shield earthing screw and the two retaining screws from the back cover. Pull the cover down and back to remove.

Release the power cord and mains plug through the holes in the back.

Unsolder the speaker and pilot lamp wires from the lugs on the top of the output transformer. Remove the two chassis retaining screws located in the front brackets at each end of the chassis and fixed into the moulded bosses in the cabinet. Loosen off the grub screws in the tuning and volume control knobs, and slide off the shafts. Remove the felt washers and slide the wave band knob and tone control knobs off the shafts.

Turn the receiver upside down on the bench and remove the pointer from the pointer drive cable. Slide the chassis back out of the cabinet.

To replace the chassis, reverse the above procedure.

ALIGNMENT OF THE RECEIVER

The chassis should be fitted in the cabinet before alignment adjustments are commenced. Switch on the receiver and allow it to warm up for a few minutes. Turn the tuning condenser to minimum capacity. See that the wave band switch is in the "Broadcast" position. Turn the volume control to maximum position and the tone control to "high." Unscrew the adjusting cores on the I.F. transformers nearly right out.

Apply a signal of 455 kc/s. modulated 400 c/s. 30 per cent. to the control grid of the converter valve ECH81 through a 0.01 μf. condenser and adjust for maximum output in the following sequence:

(1) Diode coil;
(2) EBF80 plate coil;
(3) ECH81 plate coil;
(4) EBF80 grid coil.

If the above adjustments are carefully carried out, no further adjustments should be made. Seal the I.F. adjusting slugs. The sensitivity should be less than 25 μv. for 50 milliwatts output. Remove the 0.01 μf. condenser from the control grid of the ECH81 valve and connect the signal generator by means of a standard dummy aerial to the aerial and earth connections of the receiver.

Turn the tuning condenser to the maximum capacity position and adjust the pointer at the low-frequency end of the dial. Turn the broadcast aerial and oscillator trimmers to their mid-capacity positions.

Apply a signal of 600 kc/s. to the aerial and turn the pointer to the 600 kc/s. position on the scale.

Adjust the broadcast oscillator padder until the signal is tuned in. Adjust the coil on the Ferrox-cube rod aerial by sliding the coil along the rod with an insulated stick. Use a small piece of cellulose tape to hold the coil in place until final adjustments are made. Turn the pointer to the 1500 kc/s. position on the dial scale and apply a signal of 1500 kc/s. to the aerial. Adjust the broadcast oscillator trimmer until the signal is tuned in and adjust the broadcast aerial trimmer for maximum output. Check at 600 kc/s. and again at 1500 kc/s. and adjust if necessary.

Check the sensitivity and calibration at 950 kc/s. If the calibration is not correct, the sensitivity will be low, and if 950 kc/s. tunes in at a lower frequency on the scale, then the oscillator inductance adjusting slug should be screwed in, slightly over-correcting, and the oscillator padder adjusted to correct 600 kc/s. and the oscillator trimmer to correct 1500 kc/s.

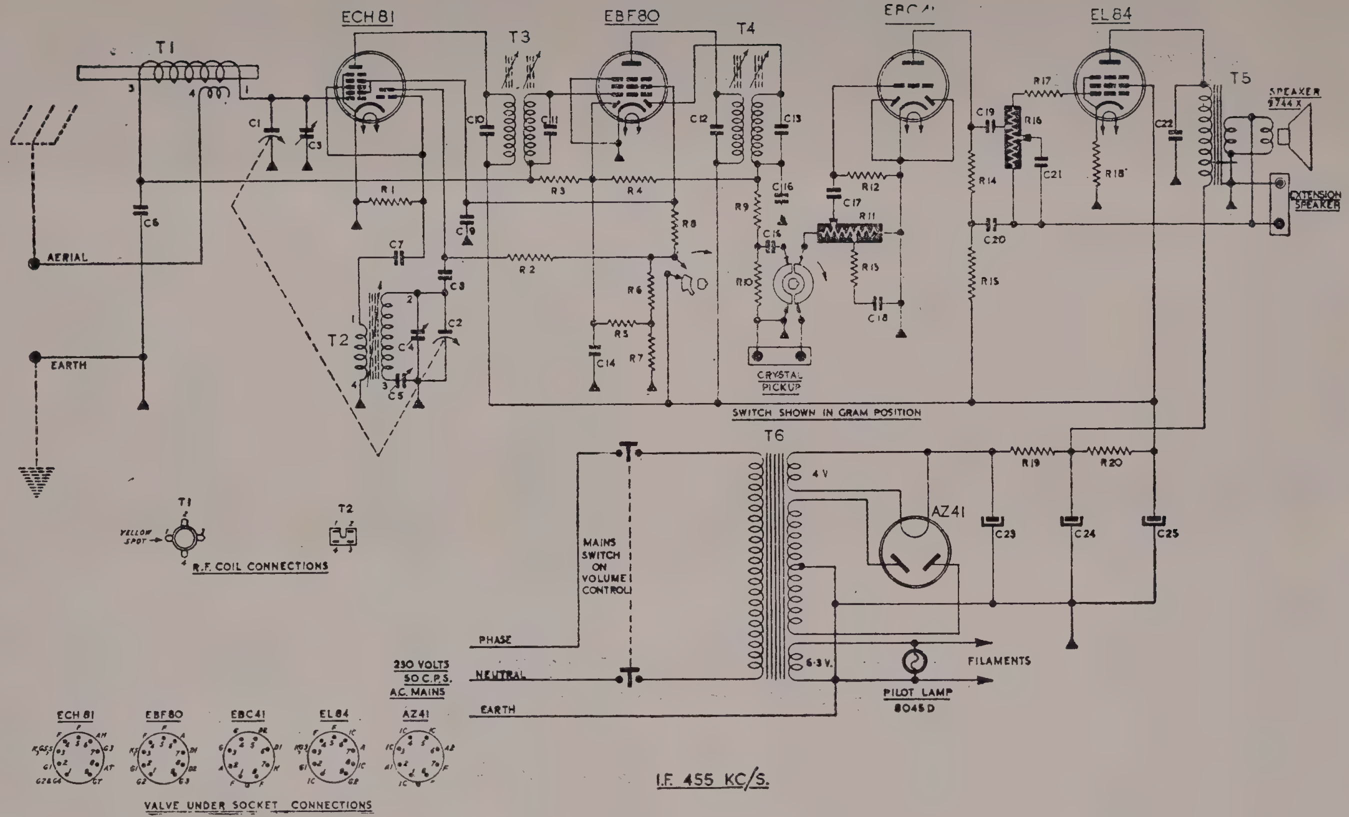
If 950 kc/s. tunes in at a higher frequency on the scale, then the oscillator inductance adjusting slug should be screwed out, again slightly over-correcting, and the oscillator padder adjusted to correct 600 kc/s. and oscillator trimmer adjusted to correct 1500 kc/s. The connection of a signal generator to the aerial terminal damps the rather high "Q" value of the Ferroxcube rod aerial. For optimum results from the rod aerial, the signal from the generator may be induced into the rod by connecting the signal generator to a loop of approximately six turns, six inches in diameter, and the rod aerial coil and aerial trimmer finally adjusted at 600 kc/s. and 1500 kc/s. respectively. This means that when no external aerial is used, the rod aerial will give maximum performance, and when a good external aerial is used the effect of the damping is offset by the increased signal. When all broadcast adjustments are completed, seal the trimmers, the oscillator coil inductance slug, and the aerial coil to the rod with wax. The sensitivity on broadcast should be less than 10 microvolts input for 50 milliwatts output.

MODEL BZ 357A ONLY

Turn the waveband switch to the shortwave band position.

Screw the oscillator trimmer to maximum capacity and the oscillator padder to the half-way position. Set the pointer to the 17 mc/s. position on the scale, and apply a signal of 17 mc/s. to the aerial. Turn the oscillator trimmer out until the second signal is tuned in, and adjust the shortwave aerial trimmer for maximum output, rocking the tuning either side of the signal as the aerial adjustment is made. Turn the pointer to the 6 mc/s. position on the scale and apply a signal of 6 mc/s. to the aerial terminal of the receiver. Adjust the shortwave oscillator inductance until the signal is tuned in and adjust the aerial inductance for maximum output.

Turn the pointer to the 17 mc/s. position on the scale, apply a signal of 17 mc/s. to the aerial, and readjust as before for calibration and sensitivity. Ap-



CONDENSERS

C1	12-500 mmfd
C2	12-500 mmfd ganged condenser
C3	3-30 mmfd air trimmer
C4	3-30 mmfd air trimmer
C5	150-750 mmfd padder
C6	0.05 mfd 350v. paper
C7	47 mmfd ceramic
C8	150 mmfd ceramic
C9	0.02 mfd 500v. paper
C10	110 mmfd ceramic
C11	195 mmfd ceramic
C12	110 mmfd ceramic
C13	195 mmfd ceramic
C14	500 mmfd mica
C15	0.01 mfd 500v. paper
C16	0.01 mfd ceramic
C17	0.01 mfd 500v. paper
C18	0.02 mfd 500v. paper
C19	0.02 mfd 500v. paper
C20	0.01 mfd. 500v. paper
C21	1500 mmfd ceramic
C22	2000 mmfd 750v. paper
C23	40 mfd 350v.
C24	40 mfd triple electrolytic
C25	20 mfd 350v. triple electro

RESISTORS

R1	47k ¼w. carbon
R2	27k 1w. carbon
R3	4.7meg. ¼w. carbon
R4	2.2meg. ¼w. carbon
R5	10meg. ¼w. carbon
R6	470k ¼w. carbon
R7	100k w. carbon
R8	22k 1w. carbon
R9	100k ¼w. carbon
R10	270k ¼w. carbon
R11	2 meg. tapped at 400k potentiometer
R12	10meg. ¼w. carbon
R13	39k ¼w. carbon
R14	100k ½w. carbon
R15	100k ½w. carbon
R16	500k tapped at 50k potentiometer
R17	1000 ohm ¼w. carbon
R18	150 ohms 1w. carbon
R19	370 ohms 4w. wire wound
R20	1800 ohms 4w. wire wound

COILS

T1	Ferroxcube Rod Aerial Coil VK 469-70.
T2	Oscillator Coil, VK 471-50.
T3	"Micro" 12" I.F. filter, A3 126 84.
T4	"Micro" 12" I.F. filter, A3 126 84.
T5	Output transformer, VK 671-01/03.
T6	Power transformer, VK 631-02/01.

MODEL BZ 356 A

ply a signal of 10 mc/s. to the aerial and check the calibration at 10 mc/s. If the calibration is not correct, the oscillator inductance should be adjusted, slightly over-correct—as in broadcast—and adjust the 17 mc/s. position with the shortwave oscillator trimmer and the 6 mc/s. position with the shortwave oscillator padder.

The oscillator padder must be adjusted with an insulated trimmer tool as the outside plates are at the oscillator grid potential. After the shortwave band has been correctly aligned and satisfactory calibration and sensitivity obtained, seal the trimmers and adjusting slugs. The sensitivity should be less than 15 microvolts input for 50 milliwatts output.

COIL AND TRANSFORMER RESISTANCES

VK 46970	Ferroxcube Rod Aerial Coil	Tuned	0.95 ohms
VK 46955	Aerial Coil, Shortwave	Primary	1.5 ohms
		Tuned	0.16 ohms
VK 47150	Oscillator Coil, Broadcast	Tuned	6.4 ohms
		Feedback	2.85 ohms
VK 47137	Oscillator Coil, Shortwave	Tuned	0.17 ohms
		Feedback	0.345 ohms
		Padder	1.5 ohms
A3 12684	1st and 2nd I.F. Transformers	Primary	8.4 ohms
		Secondary	4.7 ohms
VK 671—01/03	Output Transformer	Primary	315 ohms
		Secondary	0.6 ohms
VK 631—02/01	Power Transformer	Primary	38 ohms
		6.3v. Filament	0.15 ohms
		Secondary	380 ohms
			325 ohms
		4v. Filament	0.21 ohms

RECENT OVERSEAS DEVELOPMENTS

NOVEL PACKING FOR ACOS PRODUCTS

ACOS pick-up heads, cartridges, and styli are now packed in aluminium canisters with screw lids. Not only do these containers afford adequate protection for the various units, but they also make most attractive displays. In turn, the canisters are supplied in quantities of a dozen in specially designed boxes suitable for use as counter displays.

In the case of the HGP-39 pick-up heads, the moulded packing inserts are also designed to be screwed on to the motor board for use as a protective storage clip for the pick-up heads when the latter are not in use.

New Zealand distributors of ACOS products are Messrs. David J. Reid (N.Z.) Ltd., of P.O. Box 2630, Auckland.

THE "BIB" RECORDING TAPE SPLICER

Tape-recorder enthusiasts will hail with delight the new "BIB" tape splicer produced by Multicore Solders Ltd., England, and distributed throughout New Zealand by Messrs. Giles & Elliott Ltd., P.O. Box 1647, Wellington.

Theoretically, it is a simple matter to join broken magnetic recording tape, using a pair of scissors or a razor blade and some sticky tape. In practice, however, it is by no means easy to align the ends properly or produce a joint which will not subsequently hold up in the guides. Used in conjunction with Scotch Boy No. 41 "non-oozing" adhesive tape, however, the new "BIB" tape splicer produces a perfect joint with the minimum of effort.

The body of the splicer is a brass block grooved to a clearance fit for standard ¼-inch tape, with cork pressure pads on hinged arms located to hold the ends firmly in line. A transverse slot at an angle of about 60 degrees is provided to guide the cutter when making the scarfed joint, and parallel slots at the edges of the tape guide ensure that the joint is reduced slightly in width when trimmed—actually by the thickness of the razor blade if it is held vertical. It is important to make the direction of each trimming cut towards the tapering point on each side, otherwise there is a tendency to pull the extreme point out of the joint slightly.

Though supplied on a flock-sprayed wooden base, the "BIB" splicer can be removed therefrom and attached directly to the recorder deck by two screws, if desired. Incidentally, the instruction leaflet contains useful general hints on tape editing.

NEW AUSTRALIAN MIDGET RADIO

Meeting Australian Army specifications for a light portable radio transmitter and receiver with a range of at least 4,000 yards for battalion communication, Amalgamated Wireless (Australasia) Ltd., of Sydney, have developed a portable radio station which will operate efficiently even after being submerged in water or mud.

Called the A510 Portable Wireless Station, this midget transmitter/receiver is rugged, simple to operate, and weighs only 37 lb. It can be carried easily by one man in an infantryman's basic pouches attached to the belt, and can be used for telegraphy or telephony.

Communication can be established quickly and clearly, day or night, and in any weather, on the frequency band of 2 to 10 mc/s. Though its normal range is only about five miles, the attachment of a fixed wire aerial increases the range, under good conditions, to 500 miles.

Under actual fighting conditions, British forces in Malaya have tested this equipment with outstanding success, and it is understood that the British Army has placed an order worth £A250,000 for these equipments.

EYEGLASS HEARING-AID

Otarion Inc., of Dobbs Ferry, N.Y., U.S.A., have perfected a hearing aid which operates without a cord and looks like an ordinary pair of horn-rimmed eyeglasses.

All the parts found in a conventional hearing-aid—about 200—are assembled in a standard width and weight eyeglass frame. All wiring is invisible. A thin, colourless, and flexible tube, about one inch long leads from the bow directly to the ear and conducts sound. The microphone is in the frame directly behind the ear. The hearing-aid is powered by a tiny battery which lasts 180 hours.

Notes About New Books

(Continued from page 34)

The measuring instruments employed, notably a valve voltmeter, a signal tracer and a portable TV pattern generator, are next discussed, and then follow detailed chapters on the tracing of faults in a defective receiver. The illustrations include a series of photographs of screen pictures as they appear on incorrectly adjusted or faulty receivers, each screen being shown first as the picture appears with the test pattern signal from the transmitter, and then as it appears when using the portable TV pattern generator as signal source. There is a detailed description of each fault observed.

ILLUMINATING ENGINEERING COURSE

By H. ZUL, Philips Lighting Service Bureau. (Published by Technical and Scientific Literature Department of N.V. Philips' Gloeilampenfabrieken, Eindhoven, Nederland. New Zealand distributors, Philips Electrical Industries of N.Z. Ltd., P.O. Box 2097, Wellington. PRICE 23/6d.).

"Illuminating Engineering Course" covers the theoretical technical principles of lighting, simply, clearly and with a minimum of mathematics, and throughout relates them to the empirically based rules which govern visual perception and mental reaction.

Confined to practical, utilitarian rather than to artistic aspects, this book is intended to serve as a guide to all who, confronted with lighting problems, wish to acquire a sound basic knowledge of principles and guidance as to methods which may be used in varying circumstances.

Architects, works or production managers, as well as the young illuminating engineers, and many others who wish to understand and solve everyday lighting problems, will find this book of value, and the 170 questions and answers, carefully graded to follow the course, are a considerable help to comprehension.

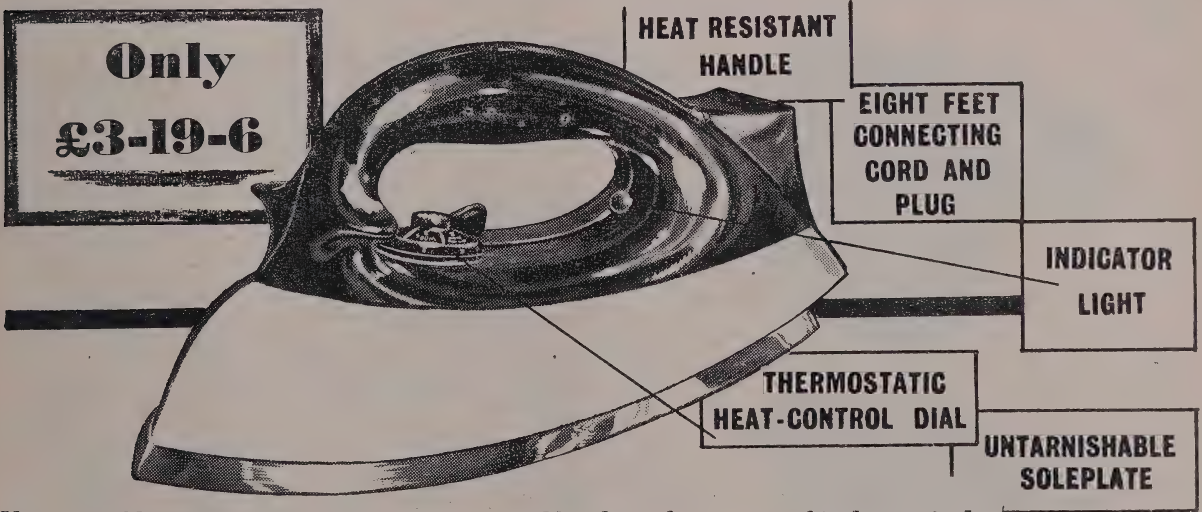
Record Talk

(Continued from page 37)

as well as New Zealand, this year. This is one of the most satisfying of the larger Brahms piano works. With the approach of Easter we have a moving setting of the "Seven Last Words from the Cross" as set by Bach's predecessor, Heinrich Schutz. The Vienna Academy Chorus are conducted by Ferdinand Grossmann on Vox PL 6860. There is some little known church music by Mozart in the form of two short masses on PL 7060, the same choir being associated with the Vienna Symphony Orchestra again under Grossmann. Then we have what is possibly the first release here of a full scale Handel opera, "Julius Caesar", by a Viennese ensemble under Hans Swarowsky (PL 8012, 4 sides). Handel's operas as a whole have been a closed book for some time, but they were enormously popular in their day and some of them have recently enjoyed stage revivals all over Germany.

From Mercury there are the indefatigable Crew Cuts with their "Chop Chop Boom" and "Don't Be Angry" (M 4119) and they are also to the fore with "Dance, Mr. Snowman, Dance" and "Twinkle Toes" on M 4131. Ralph Marterie has appropriated Puccini's "Oh, My Beloved Daddy" and paired it with a revival of "Ciribiribin" done in mambo style this time (M 4125); while Jan August's "Rumba Bells" is none other than that hallowed old classic "La Campanella" turned inside out on M 4147 and backed by "Jamboree" which in its turn turns out to be "Oye Negra"!

On the small extended play Mercury releases we have some short organ pieces of Bach's played by Ernest White (EP-1-5106) and harpists Carlos Salzedo and Lucile Lawrence play four tasteful numbers on 5006. The classical LP selection offers some dazzling performances; the symphonic arrangement of "Porgy and Bess" as played by the Minneapolis Symphony on MG 50016 should find wide favour, for instance. The complete "Nutcracker" Ballet I have already mentioned: this is unquestionably first class in every way but the price asked is so enormous as to be almost incredible.



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On H.M.V. Eartha Kitt has hit parade material with "Sweet and Gentle" which, as usual, sounds as though intended for her alone when she sings it; the reverse is "Fredy" and in both she is supported by Perez Prado. The Ames Brothers are in melodious mood with "My Bonnie Lassie" and "So Will I" (HR 10138) and Burl Ives tells us all about "Old Betsy", who turns out to be, not his or anyone else's aunt, but Davy Crockett's rifle. It shares DNZ 5109 with "Be Sure You're Right". Chris Hamalton's newest organ disc is "Mexican Madness" coupled with "Whistling Rufus" on Decca F 10532, and Leroy Anderson is represented by two more of his engaging tunes, which he conducts himself on DNZ 5123, they are "Bugler's Holiday" and "Summer Skies". For those who like to step it up a bit there are Earl Bostic, with "Dream" and "East of the Sun" on NZP 23, and Louis Armstrong with "Blueberry Hill" and "Baby Won't You Say You Love Me" on Y6233.

There is as much variety as ever in the lighter LPs, for instance, the popular Eddie Fisher will sing to his—and your—hearts' content on DLP 1074 with "My Serenade to You", comprising no fewer than twelve soothing numbers. Show tunes are once again to the fore. The sound track of the exuberant "There's No Business Like Show Business" can be enjoyed afresh on Brunswick LAT 8059, and an older but equally appealing production is recalled with the revival of "On Your Toes" on LAT 8061. This is a good old Rodgers and Hart musical, and contains, among other numbers, the "Slaughter on Tenth Avenue" ballet which was so popular some years ago. A selection from the English production of "Can Can" is to be had on Parlophone PMD 1017.

Rawicz and Landauer celebrate their switch to Decca with an LP release, but the title of LK 4094 ("The Music of Johann Strauss, Volume 1") has a rather tired look about it. Nevertheless, the old keyboard partners are in fine fettle, and so are such old favourites as "Tales from the Vienna Woods" and "Voices of Spring". Mantovani conducts us on a comprehensive journey through the music of Rudolf Friml (LK 4096) and there is, in different vein, another Ted Heath Palladium Concert (LK 4097), while in Decca's Medium Play series there is a further selection from the "immortal" works of Ketelby on LW 5140.

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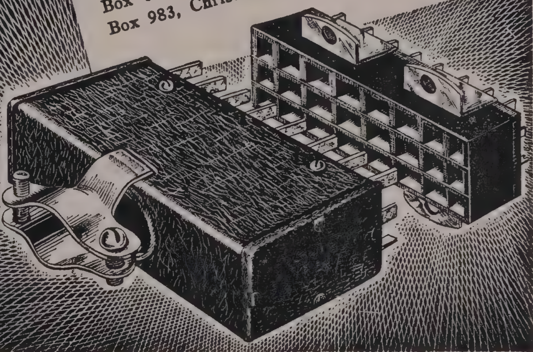

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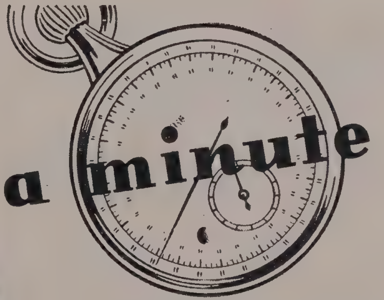

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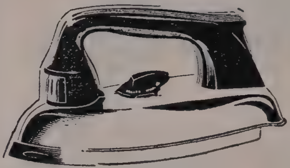

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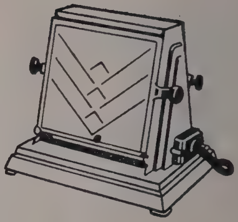

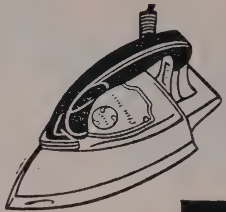

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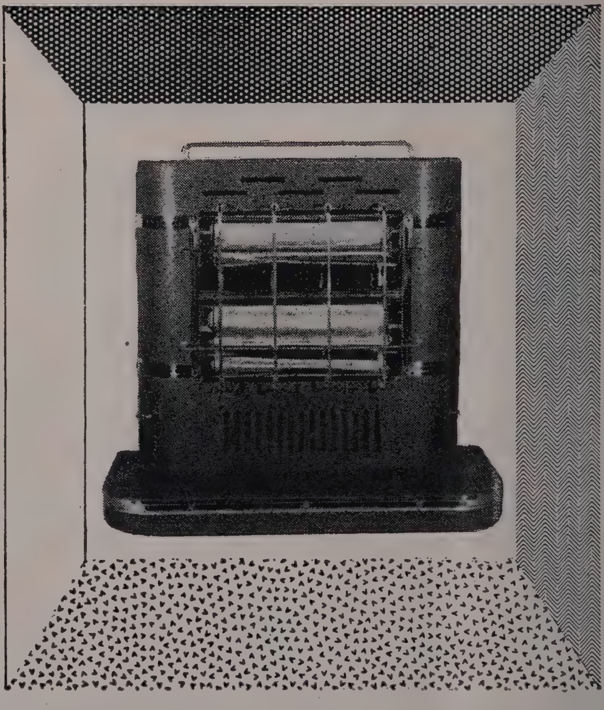

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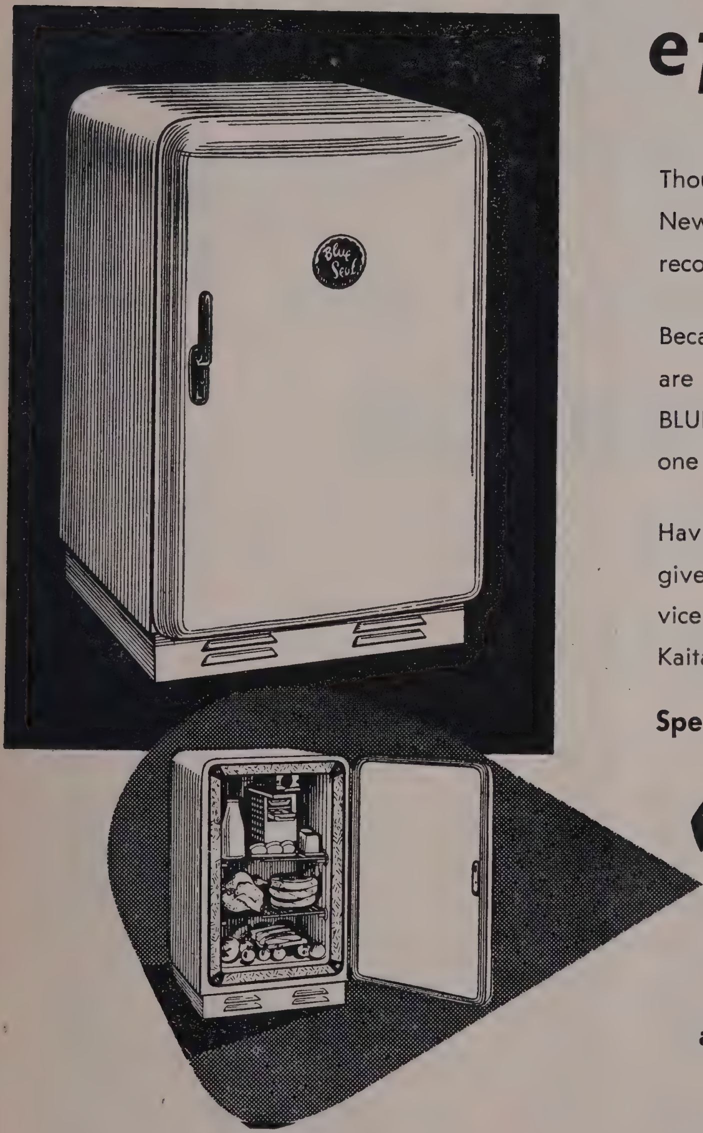

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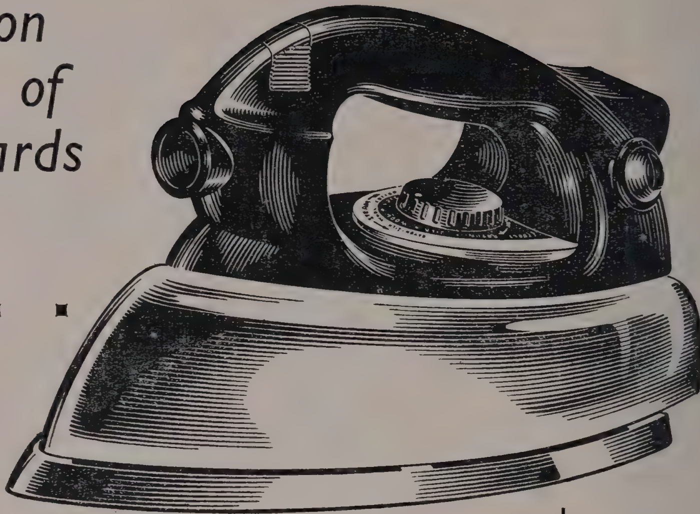

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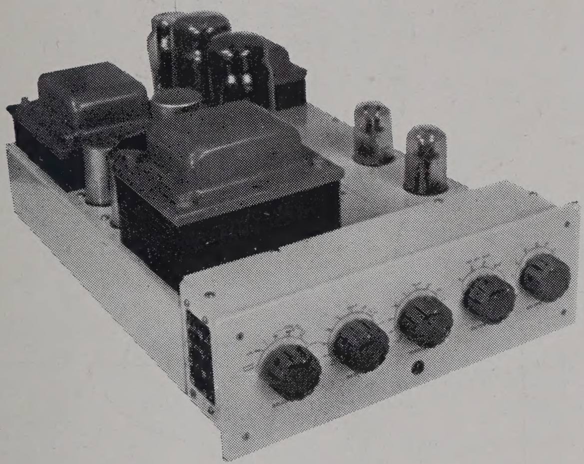

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